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THE FOOD PROBLEM OF INDIA*

ONE is at the very outset faced with several serious difficulties when enunciating the Food Problem of India. For a scientific appreciation of any phenomenon and for the formulation of a policy, certain fundamental data are essential; moreover such data must provide a realistic statistical expression of the material under study. For instance, to appreciate the food position of a country and to formulate a food policy for a nation, it is necessary that the data regarding the total requirements, available quantities of different categories of food and potentialities of increased production be ready to hand. In the case of India, lack of this precise information is the first difficulty. The importance of agricultural statistics was emphasized by the Indian Famine Commission of 1880, and since then the necessity of accurate statistics has been stressed by every committee and commission that has dealt with agricultural production. The Royal Commission on Agriculture in India recommended that the whole basis of statistics in India urgently required broadening, and laid emphasis on the fact that modern statistical methods were to make 'indispensable contribution to the successful development alike of agriculture and of social administration'. And yet, eighteen years afterwards, the Famine Inquiry Commission of 1945, recorded:

"Problems arising out of the production and distribution of foodgrains during the war, have emphasized the need for accurate statistics of acreage and yield of crops; schemes, largely experimental in character, are now in operation with the object of securing improvements in these statistics."

Without an accurate and precise assessment of food requirements and agricultural production, no agricultural planning is possible. In countries where literacy is widespread the farmers themselves help to supply the required information, but in this country statistics of every type must be collected by a suitable agency, having adequate and well-trained staff.

It has to be recognised that to be useful an agricultural survey must be comprehensive, accurate, and quick, and it must at the same time be cheap. These opposing tendencies make the task difficult. There is evidently need for a carefully developed technique. Aerial survey for crop acreage should prove in the long run comprehensive, accurate, quick and cheap. The present is a suitable time for undertaking such an experiment, as trained personnel and up-to-date equipment are available, and the technique of aerial photography has greatly developed. To obtain figures of yield special equipment will have to be designed. It should be possible, for instance, to devise a harvester which will reap a narrow strip of wheat, thresh and clean it and give the weight of grain.

If it is proposed to plan on a sound basis then the development of the science of statistics must be an important item in the post-war programme. Ignoring this branch of science will mean building the post-war edifice of progress on a foundation of sand.

* Extracts from the General Presidential Address by Prof. M. Afzal Husain, M.A., M.Sc., F.N.I., to the Thirty-third Session of the Indian Science Congress, Bangalore, 1946.

The census returns for 1941, gave the population of India as 389 millions, an increase of 51 millions over the 1931 figures, or, an increase of 1·5 per cent. per year. It will not be incorrect to say that, at this rate of increase, India starts the year of grace 1946 with a population approximating to 415 millions. Even if there is no acceleration in this speed the population of India will exceed 500 millions before 1960.

From 1901 to 1940 the recorded birth-rate has shown a slight decline, but during the same period the death-rate has shown a marked fall. Ignoring the years of war as exceptional, the excess of births over deaths has been increasing steadily and for the decade 1931-1940 the excess of births over deaths was 11 per mille. If this tendency, whatever its causes might be, continues, the rate of increase of the population will be progressively faster. Hill estimates that the population will be 650 millions by 1970. This is by no means an over-estimate. In other words in twenty-five years we shall have 235 million extra mouths to feed. Past performances justify such an assumption. The country must be prepared to face this situation unless some calamity befalls us, reduces our population, and solves the problem for us.

Since 1911, 7 million acres have been added to the same area under cutlivation in British India, but in spite of this addition the area sown *per capita* has declined from 0·9 acre to 0·72 acre, *i.e.*, by 25 per cent. During the 30 years ending 1941, the area of and under irrigation increased by 14 million acres. If it be accepted that an irrigated area gives double the yield of an unirrigated area, then, in terms of unirrigated area, the total extension of cultivation may be computed at 21 million acres. On this basis the area sown *per capita* has decreased from 1·079 acres in 1911 to 0·916 acre in 1941, *i.e.*, by 18 per cent. Therefore, 18 per cent. increased production is necessary to maintain consumption *per capita* at the level of 1911. This increase could only be attained by the increased use of manures and fertilizers, extensive use of better varieties and increased application of methods to reduce wastage. It can hardly be denied that the use of manures and fertilizers has not increased and no large-scale measures to reduce wastage have been effected. The proportion of better-yielding varieties is indeed very low. It is a little over 22 per cent. in the case of wheat, 6·2 per cent. in the case of rice and 1·1 per cent. in the case of jowar. At a most liberal estimate all the improvements effected in the yield of cereal crops still leave a deficit of 15 per cent. in the quantities necessary to provide the same rations *per capita* as were available in 1911.

Reduction in the export of food grains and increase in imports of rice may together amount to a 5 per cent. increase in the available supply. Even then India is short of food grains by at least 10 per cent. *per capita* when compared with conditions which existed thirty-five years ago, and at that period food was by no means plenty, and famines were not unknown. There is thus not the slightest doubt that the food position has been deteriorating.

Let us compare our position with that of the United States of America, which shows a higher yield per acre of all crops when compared with India. Baker calculated that for a "liberal" diet containing meat, fruits and green vegetables in maximum quantities and a quart of milk per day, 3·1 acres of land were required *per capita*. For an "adequate" diet this area would vary from 1·8 acres to 2·3 acres *per capita*, according to the quantity of milk and other nutritious foods included in the diet. An "emergency restricted diet", which contained mainly cereals and was designed to tide over difficult times and short periods of privation, 1·2 acres *per capita* was the minimum required. Even this is 33 per cent. more than the area *per capita* available in India. This comparison is enough to show the low nutritional standard of the population in this country.

Deficiencies and their Consequences

It has been estimated that to feed a population of 400 million India needs an increase in cereals to the extent of 10 per cent., in pulses to the extent of 20 per cent., in fats and oils 250 per cent., in fruit 50 per cent., in vegetables 100 per cent., in milk 300 per cent., and in fish, flesh and eggs 300 per cent. These figures are staggering, because first of all these deficiencies have to be made up for the proper nutrition of the existing population, and a further increase has to be assured to meet the demands of the increasing population. For instance, to provide adequate nourishment for a population of 500 million in 1960, the production of cereals will have to be increased by 37·5 per cent., pulses by 50 per cent., fats and oils by 337·5 per cent., milk and fish, flesh and eggs by 400 per cent. With such deficiencies in food resources, it is not surprising that the Nutrition Advisory Committee have found from the results of actual "surveys of both typical urban and rural groups that the calorie intake of some 30 per cent. of families is below requirements and that even when the diet is adequate it is almost invariably unbalanced, containing a preponderance of cereals and insufficient protective foods of high nutritive value". There cannot be any disagreement on the point that "malnutrition promotes a state of ill-health and lower physical efficiency, short of actual disease; which are perhaps more important because more widespread than disease itself". Therefore, the Nutrition Advisory Committee correctly lays stress on the fact that "freedom from disease is one thing, abundant health is another" and "the goal to be aimed at is the creation of a healthy and vigorous population".

Solution of the Problem

The solution of the complex problem of providing adequate food for our population lies in the increase of the supply and, if possible, the decrease of demand.

On one extreme we have those who maintain that India is greatly over-populated and that her food resources have not kept pace with the rise of population and are progressively falling short of the minimum requirements and, therefore, "our present need is that the growth of population should be checked and even its decline welcomed!" They say: "Judged from any point of view a check on the growth of the population of India is an urgent

necessity" (Chand). There can be no doubt about the urgency of such an attempt as it would bring about a measure of relief and allow scope for adjustment. A stationary population for some years would avoid "futility and frustration" which the present situation strongly suggests. However desirable, a check on the growth of population may be, it is difficult to attain. Nevertheless, we may look at this problem from another point of view.

The United Nations have now accepted the responsibility for meeting the food requirements of all people. They must, therefore, determine the production of food and control its distribution. We are already hearing of world's wheat pools. The necessary corollary to this responsibility is that the United Nations will have to watch the population trend of various countries. What will be the attitude of the nations with a low or controlled birthrate towards another nation with an uncontrolled and very high brith-rate? Will not the United Nations Organisation be justified in exercising some control over population? Having accepted membership of the community of nations, India will have to fall into line with the rest of the world. The solution of the population problem is not easy and at any rate it will be many years before a satisfactory solution can be found. In the meantime an increase in population will continue.

On the other hand there are those who firmly believe that "Nations can live at home" (Wilcox), and see in the development of the modern science of agrobiology the possibility of a manifold increase in the produce from land. They claim that the problem is not of *over-population* but of *under-development* of the natural resources and inadequate untilization of human knowledge to develop these resources. For instance, Wilcox places the theoretical limit of the yield of wheat at 171 bushels and of potatoes at 1,330 bushels, while the average in U.S.A. is only 8·4 per cent. of this 'penultimate' limit in the case of wheat and 8·6 in the case of potatoes.

Neither the policy of population reduction nor the magic wand of agrobiology can bring forth immediate results. The time factor is important. The Bengal Famine and insecurity of the food position are clear warnings. A sound policy would be to base our programme on the results previously achieved and attempt to evolve a scheme of increased food production from existing resources, leaving future enhancement of production for the increased population.

Unfortunately, determining food requirements by calories has produced an attitude more in favour of quantity than quality, and this has made it difficult to arrive at a scientifically correct food policy. Cereals have assumed unnecessary importance at the expense of "protective" foods. All those who have studied the food problem of India have emphasized this point. Colonel Macay held that with a low protein consumption deficiency in stamina, moral and physical, must be expected. According to John Russell the well-balanced diet for India "does not require more but less cereal than at present, but it includes more of everything else, especially vegetables, fruit and milk, and one great need for the food supply is to increase the production of these three". He advocated an increase in the yield of staple crops so as to liberate land for the cultivation of supplementary foods. India's ill-balanced diet, which has led to extensive malnutrition, is a far more serious national problem than any mere deficiency in the quantity of food. The population is degenerating in physique and in stamina. How else can one explain the curious phenomenon that lakhs died in Bengal without attempting to obtain food by fighting for it! To arrive at a correct appreciation of the food situation, it is necessary to deal with the various constituents of the diets, and not talk of calories, however convenient the slogan may be.

Let us shake off the cereal mentality and the talk of carbohydrates, fats, proteins, minerals, vitamins and so on, and make an attempt to evolve a scheme of a 'balanced diet' containing as far as possible all the ingredients in their correct proportions.

Requirements of Carbohydrates

The present position is that over 72 per cent. of the carbohydrates of human food are derived from cereals, about 20 per cent. from sugarcane, and the balance mainly from pulses. India, with 90 per cent. of her cultivated area under food-crops and 64 per cent. under cereals, is short of rice and is barely self-sufficient in other cereals. In spite of an intensive "Grow More Food" campaign, increased production has not kept pace with increased demand, and India is seeking imports at least at the pre-war level. It does not seem likely that India will obtain rapidly enough such a phenomenal rise in her soil fertility, such colonization of vast tracts of land, such rapid extension of irrigation, as to make up the existing deficiencies and provide for the future population, from a cropping scheme built round 64 per cent. area under

Cereals

In the circumstances India must produce, per acre, quantities of carbohydrates much in excess of what cereals can possibly yield. Because, if the required quantities of fuel foods can be produced from a smaller area, it would be possible to release land for the increased production of pulses, fats and oils, and "protective" foods of vegetable and animal origin, in which India is greatly in deficit. Tubers will satisfy this requirement.

In all countries where the population has increased, cereals have been increasingly replaced by tubers. For instance, in Germany, area under potatoes is 25 per cent. of that under all cereals. In England, it is 17·8 per cent. Even U.S.S.R. has 17·6 million acres under potatoes. In Java, one of the most thickly populated parts of the globe there has been, since 1916, a great increase in the cultivation of cassava and sweet-potato. In many countries of Europe potato shares with cereals, more or less, on a basis of equality, in the carbohydrate supply of the human diet. Even in the United States, in spite of the availability of land, the ratio of cereals and potatoes in the diet of a household of the lowest income is 79·8 to 64·4.

Food Value of Tubers

As regards their food value: reduced to the same standard of moisture, tubers are richer in carbohydrates, mineral matter and calcium than cereals; they are, however, poorer in pro-

teins and deficient in fats. The great advantage of tubers over cereals is the yield per acre. If the average yield of rice and wheat in India be taken as 10 maunds per acre (although it is less), and the average yield of potatoes be taken as 75 maunds per acre (although it is more than 100 maunds), the per acre yield of various constituents of food will be very much higher in the case of tubers, except fat in potato and protein in cassava.

With a reasonable standard of cultivation, a yield of 200 maunds per acre is not difficult to attain in the case of potato, sweet-potato and cassava. With this yield the potato will provide a quantity of carbohydrates at least four times that of wheat, and sweet-potatoes and cassava about five times.

The superiority of rice and wheat in contrast to tubers is their high protein content. There seems no reason why India should persist in obtaining her protein supply from cereals. She must obtain the various ingredients of diet food sources from which they can be produced most efficiently and economically. In other words carbohydrates must be obtained mainly from tubers and cereals, if possible in equal proportions; proteins from pulses and animal sources such as milk, fish, flesh and eggs; fats and oils from milk and oil seeds; minerals, vitamins and other ingredients from such sources as supply them most economically.

In addition to providing large supplies of carbohydrates, minerals, calcium and phosphorus per acre, tubers can be used as fodder for livestock, as a source of starch for food products, such as biscuits, and a raw product for the manufacture of dextrine, glucose and sizing for the textile industry. In these respects they outstrip cereals. From the agricultural point of view, they loosen the lower strata of soil and lead to soil improvement. Potatoes respond to better cultivation and provide increased occupation for the farmer. There are some varieties of tubers that yield two and three crops a year, in which case the yield per acre is exceedingly high.

The greatest obstacle in the extension of the area under potatoes in India is the nonavailability of sound, healthy seed in adequate quantities, at the right time and at a reasonable price. The crop grown in the plains gets diseased and, therefore, seed has to be brought from the hills or imported from abroad. Researches have shown that healthy seed can be produced in India, and according to Burns, "given disease-free seed-potatoes and suitable manuring, the production of potatoes on the existing acreage can be doubled". Steps have been taken by the Imperial Council of Agricultural Research for the production and distribution of healthy seed. There are vast areas which provide suitable soil and climatic conditions for potato cultivation and in many parts of India two crops can be raised in a year.

Sweet-Potato

If potato is the tuber of the cooler regions, sweet-potato may with greater justification claim to be the tuber of the warmer regions of the gobe. If potato is the tuber of the West, sweet-potato is the tuber of the East. "The Chinese cultivate sweet-potato on a very large scale, and it enters into their diet, in some parts even more than rice." During 1943 the U.S.A. had 900,000 acres under sweet-potatoes, mainly in the Southern States. Some varieties of sweet-potatoes are only three-month crops. Even two crops a year, each yielding 200 maunds of tubers, grown over a moderate area, would convert Bihar and Bengal from deficit to surplus provinces, not only for carbohydrates but by releasing area for fodder, which will also increase the supply of milk.

Sweet-potato has this advantage over potato that it can be grown from stem-cuttings and the seed problem, the greatest obstacle in the extension of area under potato, does not arise. Again its demands for soil, manure and irrigation are not exacting either.

Proposals

If India could grow cereals and tubers in the same proportion as the pre-war Germany, *i.e.*, in the proportion of 4:1, India could supply in full her present requirements of carbohydrates from an acreage equal to 60 per cent. of what is under cereals now. Even if 10 per cent. of the acreage now under cereals be diverted to tubers, India's carbohydrate supply will be increased by 33 per cent. By following such a policy, land could be released for pulses, oil-seeds, fodders and a more balanced diet obtained.

The proposal I place before you is that, if the area under cereals is reduced from the present 64 per cent. of the total sown to 45 per cent. or so, and of the area thus released, 5 per cent. of the total sown be planted with tubers, and the acreage of pulses be increased by 20 per cent., the out-turn of carbohydrate will be much in excess of the present quantity. I have taken tubers as an instance of high-yielding crops. Equally satisfactory results can be obtained from plaintains, which yield over 200 maunds of fruit per acre, and produce as much carbohydrate as sweet-potato or cassava with 100 maunds to the acre. They are also decidedly richer in proteins. Another high-yielding crop is carrot, which has the added advantage of being a rich source of carotene.

Requirements of Fats and Oils

India's requirements of fats and oils have been placed at 250 per cent. in excess of the available supply. The area released from cereals could permit the acreage under edible oil-seeds being doubled. This would also double the quantity of concentrates for feeding milch-cattle, and if a reduction in the number of bullocks can be brought about simultaneously, as suggested later on, there will be a further improvement in the food resources of milch-cattle. The introduction of a Soya bean, a legume rich in oils, will greatly enhance the supply of edible oil. In planning the nutrition of the whole world, the advisability of exporting oil-seeds from a country grossly deficient in fats and oils, will, we hope, be determined by the FAO.

Protein Deficiency

Deficiency in total proteins, and more particularly in the proteins of high biological value, is India's most serious nutritional problem. This deficiency may not manifest itself in mortality and disease, but is evident in the slow rate of growth, reduced size of body, lack of efficiency and vitality. That this is actually the case is abundantly manifested by the con-

dition of both men and cattle. Dr. Burns has correlated the amount of food and body-weight in cattle of the different regions of India, and Radhakamal Mukherjee has made similar studies in human groups. It is apparent that where cattle are ill-fed and small in size, and milk production per head of human population is low, the human physique is poor. Average live-weight of cattle and man is fairly closely correlated.

Pulses and cereals are the chief source of vegetable proteins. Reduction in the area of cereals will reduce the quantity of proteins of this source slightly, but a 20 per cent. increase in pulses will make up the deficiency. It is, however, the increase of proteins of high biological value, which is India's greatest need.

The Nutrition and Food Management Committee of the FAO have recognised that "the primary objective of the nations united in the Food and Agriculture Organization is to raise the level of nutrition throughout the world, to ensure not only that all people are freed from the danger of starvation and famine, but that they obtain the kind of diet essential for health". Our Food Policy should aim at 'abundant health', and our goal should be 'the creation of healthy and vigorous population', able to shoulder the burdens of peace and war.

Protective Foods

Let us now deal with the foods of animal origin "protective foods" and proteins of high biological value, provided by fish and flesh, eggs and milk. The requirements of these foods for 400 million human beings is estimated at 300 per cent. over and above the present supply.

The most important of the food resources of this category are fish. The extensive waters around the coast of India, vast estuarian areas, numerous rivers and canals, lakes and tanks provide almost unlimited possibilities for the production of fish. Fish may be described as the food ready-made for man to collect. The neglect to develop, nay even to control, the fisheries in India has been colossal. It is only under the stress of war-time food scarcity that the necessity of developing this valuable source of food has been recognised. It is encouraging to find that severeal Provinces and States as well as the Central Government have taken steps to develop the fishery resources of the country. Programmes of development include all aspects of the fish industry, and teaching and research. We can look forward with confidence to the full development of this source of food. An abundant and cheap supply of fish will solve the problem of a balanced diet for the enormous rice-eating population No effort should be spared to develop fisheries.

Sheep, goats, pigs and poultry are well-known sources of food. The Imperial Council of Agricultural Research are financing research on these animals, with a view to improve breeds and increase the quantity of food produced from these sources. Among the smaller animals, a useful source of wholesome flesh is the rabbit. It multiplies very rapidly and grows quickly. In other countries rabbit-breeding is an important industry, and it is a pity that in India nothing has been attempted so far, and this excellent source of very good food is being ignored.

Investigations carried out in America indicate the importance of wild life. It has been shown that where marshes have been leclaimed for cultivation, the benefit gained has not compensated for the loss sustained, through the destruction of water-fowl. We have approximately 200,000 square miles of forests. Can they not be stocked with eatable birds? There is immediate need for a thorough survey and population study of the wild life of Idina as a preliminary to a national planning of game improvement.

The Cattle Problem

Of the livestock the most important are the cattle and they occupy a unique position in the rural economy of India. They provide the draught animal for cultivation, contribute to the fertility of soil by providing farmyard manure—the only manure readily available to the farmer. Cattle dung makes up for the deficiency of fuel resources for household needs. Cows and buffaloes provide milk—a perfect food—and in a country where a large section of the population is vegetarian, the milk supply is of great importance. The cattle, finally, provide flesh for human consumption and their hides, bones and horns are products of considerable value in industry. Indeed the place of cattle in the economy of Indian farming is so fundamental that the ancients considered that the bull carried the earth on its horn, and they deified the cow. Paradoxical though it may appear, yet it is a fact that a stage has been reached when on the one hand cattle provide food for man and on the other compete with him for food. It is true that cattle mostly live on straw and stalk—bye-products of grain production—yet the pressure of population has forced man to encroach upon pastures and break land for the cultivation of food-crops with loss of fodder for cattle. The result is that to-day there is great scarcity of cattle feed. Cattle are underfed, inefficient, and too large a number has to be maintained. India possesses one-third of the world's cattle population. Without adequate feeding, improvement in breeds is a hopeless task.

Burns estimates that the total number of bouvine adults in British India is 107 million and the total feed available is 175 million tons of roughages and less than 4 million tons of concentrates. Ignoring the requirements of young stock, the deficiencies are: 50 million tons of roughages and 9 million tons of concentrates. Of the available food, work-cattle get the larger share, and milch-cows are starved.

In 1940, there were in British India 49 million working bullocks and uncastrated males over three years of age, kept for work. All those who have studied the food and agricultural problem of India have advocated the urgent need of reducing the number of bullocks, so that the cows are better fed and the milk supply is thus increased. For instance, the Royal Commission on Agriculture in India emphasised the "necessity of attention on all matters that will tend to decrease the number of bullocks required for cultivation". Sir John Russell followed in the same strain and said, "If it were feasible, the best course would be a large reduction in numbers of animals so as to bring livestock population more into line

with the supplies of food, but this cannot be done rapidly. Some gradual reduction will no doubt come about by economic pressure as the grazing-grounds become more closely scattered for cultivation, and as the castration of scrub bulls becomes more commonly practised. Improvements in farm implements and particularly in the bullock-cart, would reduce the need for so many bullocks in the village".

Improvement of farm implements, or bullock carts with ball-bearings and pneumatic tyres, do not even scratch the surface of the problem. Co-operative use of inefficient bullocks is not a practical proposition when, on account of the shortness of season for the preparation of land, the available period for cultivation is limited. Small holdings will continue as long as there is no outlet for the rural population in industry. Utilising animal labour for cultivation and transport is a most wasteful method. It has been estimated that in many parts of India the work-cattle are employed for half the year, and yet they have to be maintained and fed throughout the twelve months. The Royal Commission have stated that bullock labour is a heavy item in crop production.

The *only* effective measure that will reduce the number of work-cattle is mechanization. Here is a pciture of a fully mechanized cotton farm in the U.S.A. "Tract-drawn equipment plants and cultivates the crop. Flame throwers kill the weeds. Airplanes dust the cotton with insecticides and, a week before the cotton is mature, they apply a cyanamide compound which makes the leaves drop off. When the leaves are gone, the cotton picking machine moves in. A cotton picking machine can pick a thousand pounds of cotton per hour, instead of 15 pounds a man can pick. Such a machine works all day and then with headlight on it works all night."

At the present time the aim in India should be to replace animal labour by machine and thus save food which is now consumed by the work-bullocks. What would be achieved as a result of such mechanization may be illustrated by taking an example from the U.S.A. "About 1920 there were 26 million horses and mules in the United States of America and by 1940 there were less than 16 millions. In 1919, there were 160,000 tractors, and by 1939, they had increased to 1,600,000. This has meant a release of 35 million acres of land the production of which was required to support work-stock." Imagine what similar reducion in the number of bullocks would mean to the human population of India. The fodder thus saved and fed to cows would bring about an immediate increase in the milk supply. Do we not know that a 60 per cent. increase in milk yield can be obtained by good feeding? Further with an assured supply of fodder the breeds can be improved, resulting in increased effi-ciency of milch cattle.

One of the post-war development plans is to take motor transport right into the heart of rural India; this will mean the replacement of bullocks now used for transport. There are schemes of hydro-electric development which will provide motive power for water-lifting, cane-crushing, corn-grinding, for which bullocks power is being used at present. A very real step towards the reduction of the number of bullocks will be the introduction of tractors.

The present is the most appropriate time for launching a campaign for the mechanization of agriculture. The price of bullocks is high. There are thousands of trained mechanics, familiar with tractors and other power-driven machinery, who will be released from the army. The chief difficulty, however, is that tractors are not available, and designs suited to Indian conditions have not been determined.

In my opinion the first step that should be taken is to hold an exhibition of tractors and farm machinery on a very large scale, to which tractor manufacturers and producers of farm machinery should be invited from all over the world. This would enable agricultural experts and manufacturers to determine which models are most suited to conditions obtaining in India. The next step would be to establish a tractor manufacturing industry and a fully-equipped Institute for Research on Tractor Designs to guide such an industry. The first need of India is is not luxury motor cars but sturdy tractors, of moderate size and moderate prize, which run on cheap fuel.

Increased Production of Vegetables and Fruit

The consideration of increased production of vegetables and fruit need not delay us too long. By proper management, use of good seed, and plants of high-yielding varieties, production of these useful and necessary foods can be greatly enhanced from the existing area. A system of cropping in which orchards are intercropped with fodder or vegetables, will mean better use of the land. For instance, fodder could be grown in a vineyard, an orange grove or a mango orchard. Carefully planned trials alone will determine the most rational use of land, as various conditions will determine what can be achieved, and these conditions vary from locality to locality.

Conclusion

To sum up: A national crop planning should be based on the best and most efficient utilisation of land and other resources for social needs. The first social need is food. It is possible to evolve, for the various parts of the country, cropping schemes which will result in greater production of carbohydrates from smaller areas, than is the case at present. In any such scheme tubers will play an important part, and the area under cereals will have to be reduced. Acreage released from cereals can be devoted to pulses, oil-seeds, fodders, an increased production of which is necessary for obtaining well-balanced diet. The increased food for milch-cattle, both in roughages and concentrates, which will result from such a cropping scheme, will make up our existing deficiencies in milk—a most necessary 'protective food'. The introduction of more legumes, *i.e.*, pulses as well as fodders, will enrich our soils. A reduction in the number of bullocks by encouraging the use of tractors and motor transport, and the introduction of machinery driven by cheap electric power, will release much fodder and enable us to improve our breeds of milch-cattle, with a consequent increase in milk production.

All this is possible and we have the knowledge to do it, but as the Hot Springs Conference stated—'It requires imagination and firm will on the part of each government and people to make use of that knowledge".

ANNUAL SESSION OF THE INDIAN ACADEMY OF SCIENCES HELD AT UDAIPUR

THE Indian Academy of Sciences, Bangalore, held their Eleventh Annual Meeting jointly with that of the National Academy of Sciences in the historic city of Udaipur from the 26th to the 29th December 1945. The Session was inaugurated by a Message from His Highness the Maharana Sahib Bahadur of Udaipur.

The Presidential Address to the Indian Academy of Sciences was delivered by Sir C. V. Raman on "The Crystal Forms of Diamond and their Significance", which he illustrated by means of large-size wooden models of the crystals of diamond. Diamond is unique among crystals in that it really exhibits the usual external form of plane faces bounded by sharp edges, which is considered to be characteristic of all crystals. It is, therefore, incorrect to attempt to describe the crystal forms of diamond in terms of the usual nomenclature of geometrical crystallography, which makes use of the plane faces for this purpose. On the other hand, what is really characteristic of a crystal of diamond is the set of edges which form a network of intersecting lines on the curved surface. Sir C. V. Raman suggested that these edges are fundamentally related to the internal architecture of the crystal and that they invariably lie in a plane containing the valence-bonds within the crystal. There are six such planes, which cut the surface into 24 segments, and every diamond exhibits only 24 segments on its surface. The 48 segments which should be present if diamond possessed the holohedral symmetry of the cubic system are never found at all. On the basis of these ideas, it is also possible to explain the origin of some peculiar forms of diamond, as for example, the fact that flat triangular natural crystals are always twinned and so on.

The Presidential Address to the National Academy of Sciences was delivered by Professor K. S. Krishnan on "Electron-Scattering in Metals and Alloys in relation to their Electrical Resistivities". Prof. Krishnan explained how modern quantum mechanics have led to the postulation of electron waves within the lattice of a metal, and how the resistance of a metal or an alloy arises essentially from the scattering of these electron waves. He pointed out that the problem of evaluating the scattering coefficient for electron waves can be attacked from the same standpoint as that used in the scattering of light waves, namely, by making use of the theory of fluctuations due to Einstein and Smoluchouski. For pure metals, the fluctuations in density alone need be taken into account, while with alloys the fluctuations in the relative concentration of the components also come in, for which reason the resistivity of alloys is in general greater than that for pure metals. The calculations made on this basis agree well with the known data on the resistivity of metals and alloys.

A number of symposia were held on a variety of subjects of interest to physicists, chemists, geologists and agriculturists. One of the symposia on "The Age of the Saline Series in the Salt Range of the Punjab", convened and presided over by Prof. Birbal Sahni of the Lucknow University, lasted for one and a half days. A large number of official and non-official geologists and paleo-botanists took part in the discussion, and no less than fifteen papers were considered.

The problems of agriculture in India received much attention during the Session, and two symposia were exclusively devoted to this subject and were attended by officials and non-officials from various parts of India. The first symposium was on the "Role of Plant-breeding in the Development of Indian Agriculture". The principal speakers were Dr. Shri Ranjan of the Allahabad University and Mr. K. Ramiah, Plant-Breeding Expert at Indore. The theory and practice of plant-breeding were reviewed in the symposium with special reference to the need of the practical agriculturist in various parts of India. The importance of breeding for such special qualities such as disease resistance and draught resistance in addition to increased yield were stressed. Dr. Shri Ranjan exhibited a series of new wheats developed by him using the X-ray technique.

There was also a symposium on the very important subject of getting accurate "Statistics of Crop-Production in India". The need for reliable data regarding both food and money-crops can scarcely be overstressed. Dr. P. V. Sukhatme of the Imperial Council of Agricultural Research led the symposium with a brilliant exposition of the ideas and methods which he has developed for the purpose. These are strikingly different from those advocated by the Calcutta School of Statisticians. The results already obtained by the new method indicate that they are of great value and could be recommended for adoption everywhere in India. The above speaker was followed by a whole group of speakers who described the technique and their results for different crops.

There were also symposia on subjects of academic interest in physics and chemistry. Dr. S. V. Anantakrishnan of the Madras Christian College opened a symposium on the "Electronic Theory of Valency" in which he traced the development of the theory with particular reference to the more recent trends in the subject following the classical investigations of Heitler and London. A lively discussion followed in which numerous chemists and physicists took part.

A symposium was also held on the "Structure and Properties of Diamond" in which various properties of diamond such as its fluorescence, phosphorescence, absorption, magnetic rotatory power, thermal expansion and other properties were reviewed. A number of new results recently obtained in Sir C. V. Raman's laboratory were presented by his co-workers.

There were public lectures in the evenings on subjects of popular interest. Dewan Bahadur Dr. Ramanathan delivered an illuminating lecture on the services which a well-organised department of meteorology could render to the country and especially to the agriculturist.

Mr. E. R. Gee of the Geological Survey of India gave a highly interesting account of his travels in Afghanistan, illustrating his talk with the projection of a number of photographs taken by him of the country and of the people. Mr. Ramiah delivered a popular lecture on the subject of plant breeding. He emphasized the need for systematic researches on the genetics of plants indigenous to India. He suggested that the systematic use of hybrid seed which is now universal in U.S.A. for maize could prove most useful in those parts of India where the production of this crop is important.

Excursions were also arranged to visit some of the beauty spots in the city and places of interest in the neighbourhood.

SYMPOSIUM ON MINERAL RESEARCH IN INDIA

UNDER the auspices of the National Institute of Sciences of India, a Symposium on Mineral Research for Developing Mineral Industries in India was held at the Delhi University recently.

The Hon'ble Sir Ardeshir Dalal, Member for Planning and Development, Government of India, in inaugurating the Symposium, expressed the hope that the papers and discussions and the deliberations of scientists gathered at this meeting, would help the Planning Department in their post-war plans for exploring the mineral resources of India.

In his opening address, Mr. D. N. Wadia, President of the Institute, and Mineral Adviser, Planning and Development Department, Government of India, spoke on India's existing mineral resources, its chief assets and deficiencies, the neglect mineral industries have hitherto received in India, due to its economics being based on export of raw minerals rather than domestic utilisation and outlined a long-range national plan for minerals.

Twenty-five papers were presented for reading at the Symposium which lasted two days. A large number of Fellows and many distinguished scientists attended the meeting and took part in the discussions.

Messrs. A. O. Rankin, F.R.S., and P. Evans, in a paper on "Geo-physical prospecting for oil in India", referred in some detail to the history of gsophysical prospecting for petroleum in India with mention of scope and cost of the prospecting programmes outlined by the B.O.C. for future. In discussing the results, stress was laid on the necessity for a unified propecting programme in which geo-physical mapping, electrical and magnetic surveys of alluvial areas and the drilling and test-wells are all closely co-ordinated. Messrs. P. Evans and W. J. Wilson read a paper on "The refining of petroleum in India and Burma". Mr. E. S. Pinfold, of the Attock Oil Company presented a paper on the "Scientific problems in the development of the oil-fields in Northwest India" and possibilities of oil exploration in that area.

Dr. J. de Graaff Hunter, F.R.S., and Brigadier E. A. Glennie referred to the "Geo-physical applications of Geodesy".

Professor M. N. Saha, F.R.S., referred to his investigation on the "Measurement of geclogical time in India" by radio-active methods.

Mr. E. R. Gee dealt with the economic minerals of Northwest India, and Mr. B. Rama Rao dealt with the scope for expansion of non-metallic industries in South India.

Professor S. K. Roy gave the results of the survey of the Jawar lead-zinc deposits of the Mewar State.

Dr. J. A. Dunn presented two papers on the position of the Geological Survey of India and the development and future position of ores and minerals in India.

Dr. F. G. Percival gave a revised estimate of the reserves of iron-ore in the Singhbhum-Orissa field, as being much in excess of 8,000 million tons.

Dr. K. R. Krishnaswami spoke on mineral research at the Indian Institute of Science. Dr. Gilbert J. Fowler, in an interesting paper, described the production of Nitre from ammoniacal waste.

Dr. C. S. Pichamuthu of Bangalore emphasised the role of universities in mineral research. Prof. A. K. Ghosh, of the Calcutta University, referred to the possibilities of exploring diatomaceous earth in India. Dr. D. P. Antia gave an interesting paper on "Powder Metallurgy" and Dr. D. R. Malhotra on "Metallurgical research in India". Dr. A. Lahiri, of the Fuel Research Institute, gave a paper on "The trends of modern research on Coal".

Evening popular lectures were delivered on the occasion by Professor M. N. Saha, F.R.S., on his experiences of Soviet Russia, and by Professor H. J. Bhabha, F.R.S., on the role of mathematics in the evolution of science.

METALS IN AIRCRAFT*

THE metallic materials commonly used in the construction of aircraft were reviewed and attention drawn to the great diversity of the metals to be found in them. Steels of various compositions were dealt with and an explanation given of the advantages to be obtained by using alloy steel of the air-hardening type. Brief references were made to the different kinds of stainless steel and also to the processes of "case hardening" and "nitriding". The opportunity was then taken to give a simplified account of the changes which occur during the heat-treatment of steel. Mention was made of numerous alloys based on aluminium and magnesium and it was explained that the mechanism of hardening in these alloys was somewhat similar to that which took place in steels. Finally, a table was given showing the densities and maximum tensile strengths of cast iron, mild steel, an alloy steel, an aluminium and a magnesium alloy—all except the first being heat-treated so as to give good mechanical properties.

FRANK ADCOCK.

* Abstract of the Inaugural Address to the Society of Aeronautical Engineers, delivered by Prof. Adcock.

THE NUCLEOLUS

BY

B. R. SESHACHAR AND K. V. SRINATH

(University of Mysore, Central College, Bangalore)

WITH the re-orientation of our ideas regarding the structure and composition of the chromosomes, there has arisen a necessity for a re-examination of the various problems relating to the nucleolus, which has not received the same amount of attention. The chromosomes, whose composition until five years ago remained a mystery, are to-day known to be composed of nucleo-proteins. Evidence in support of this has been adduced in three different ways: (1) staining reactions with dye-stuffs, (2) digestion by proteases and nucleases, and (3) specific absorption of ultraviolet radiation. The chromosome is interpreted as having a protein framework built up of peptide linkages —Co-NH— and on this framework are fixed at intervals the active groups which we know as genes. The ease with which the nucleases attack the nucleic acids of the chromosomes suggests a loose binding between the protein and nucleic acid in these structures. The linkage is believed to be salt-like (polar) and it may be considered as arising largely from electrostatic forces of attraction between the positively charged groups on the protein and the negatively charged groups (phosphoric acid) on the nucleic acid. The nucleo-protein is thus a readily dissociable complex and its integrity is governed, among other things, by the pH of its medium and by the concentration and nature of the salts present. In the mitotic cell, nucleic acid is synthesized and degraded, and recent findings suggest that there is likewise a protein cycle. In cells where the content and character of nucleic acid and protein are subject to change, the nucleo-proteins are most likely to be of a relatively loosely bound and transitory nature. At the start of the mitotic cycle (prophase) there is an accumulation of nucleic acid in the chromosome which reaches a high value in metaphase and largely disappears at telophase. This nucleic acid is of the desoxyribose type, yielding a positive Feulgen reaction; in no place other than the chromosome and the fully formed sperm is this type of nucleic acid known to occur. At the end of mitosis, small nuclear organelles are formed, which are called nucleoli, and moreover, a residuum of nucleoprotein is observed at the site previously occupied by the metaphase chromosome. This residuum, together with the nucleoli in the resting nucleus, does not contain desoxyribose, but only ribose nucleic acid of the cytoplasm. It would appear, therefore, that although the greater part of the chromosome is composed of desoxyribose nucleic acid, a part is also composed of ribose nucleic acid. The particular regions on the chromosome associated with hereditary characteristics, the genes, have been located in positions in which only the nucleic acid of the desoxyribose type is present. The part of the chromosome which presumably persists into the resting stage of the nucleus and which contains nucleic acid of the ribose type has been presumed to be genetically inert and is referred to as heterochromatin. Caspersson and Schultz[1] suggest that the heterochromatin is responsible for the synthesis of the desoxyribose nucleic acid of the euchromatin. This suggestion was largely based on the remarkable finding that translocation of part of the heterochromatin to euchromatic segments results in an increase in the nucleic acid content of the latter in the immediate neighbourhood of the translocation, together with an instability of the neighbouring genes.

Parallel with the nucleic acid cycle in the nucleus runs a protein cycle. In prophase, as the content of desoxyribose nucleic acid begins to increase, the relatively large amount of the complex protein present begins to decrease and alter into protein of the simpler histone type. At telophase, the euchromatic elements of the chromosomes begin to lose the desoxyribose nucleic acid and simultaneously to alter their protein to the complex type, whereas the heterochromatic elements produce protein of the histone type. In the resting nucleus the heterochromatin and the nucleoli contain the histone type of protein and ribose nucleic acid. The distribution of the complex and simple types of proteins in the chromosome has been independently inferred by enzymatic experiments.

That, briefly, is the picture offered of the chromosomes based on recent work. The nucleolus on the other hand, has always been held to be of subsidiary importance and though a number of efforts have been made to regard this cell-organelle from the view-point of its immediate functional importance, its true nature, and more especially, the larger problem of its significance to cell-economy have not received the same care and attention that have been directed to the chromosomes. It must, however, be said that in plant cells, exhaustive inquiries have been made in regard to the relation between the nucleolus and the chromosomes, in recent years stress having been laid on the significance, number and size, and origin of the nucleolus. In animal material on the other hand, the nucleolus still remains an obscure and ill-defined body, which in some manner, is either responsible for the synthesis of certain metabolic nutrient substances, or contributes, in the same ill-understood way, to the formation of the chromosomes.

But mainly due to the large amount of attention directed towards it by Gates and his co-workers, certain important conclusions have emerged which may be summarised as follows: The nucleolus is present in a very large majority of plant and animal cells. It is denser than the rest of the nucleus and lies embedded in it. On account of this density, it can be expelled from the nucleus on centrifuging.[2,3] While it appears to lie loose and free in the nucleus of the Echinoderm egg and is capable of being

moved inside it,[4] in the majority of plants that have been examined and in *Drosophila* and *Chironomus* it is in specific relation with a chromosome and arises next to a particular particle on it, the nucleolar organizer.[5,6] In primitive plants like *Spirogyra* and *Lomentaria*[8] a peculiar type of intra-nucleolar mitosis has been described, where the chromosomes having been formed in the karyolymph in the normal way, migrate into the large nucleolus and complete their separation there, —a very remarkable phenomenon. Quite another kind of interest is provided by the behaviour of the nucleolus in Selachian oogenesis where it has long been known[9] that as the germinal vesicle becomes developed, and synchronously with the obscuration of the chromosomes, the number of nucleoli in the nucleus increases till a very large number is found.

These and other facts regarding the number, size and behaviour of the nucleolar bodies made the problem so bewildering in its complexity that by 1925 it was believed that the astonishing variation exhibited by the nucleolus in its various aspects could only be explained by the greatly protean nature of this body, which, retaining in itself infinite potentialities, reacted differently in different environments.

But with the development of specific techniques for the detection of certain essential constituents of the nucleus it was possible to narrow down the definition of the term 'nucleolus' or analyse its chemical constituents so that it was possible to see if 'nucleolus' included in it one uniform type of body occurring throughout plants and animals or different types of structures. On this basis were eliminated the structures that were originally regarded as nucleoli but which on specific staining by Feulgen proved to be not. Thus the chromatoid body in the nucleolus in *Pentatoma* spermatogenesis[10] was proved not only not to contain any chromatin (as it was originally believed) but in fact was shown to play no part in spermatogenesis, being cast away at the end of the process as a useless structure. Because, on this basis whether the nucleolar body contained chromatin or not, the whole superstructure of the chromatin contribution of the nucleolus to the chromosomes stood or fell. As a result mainly of the appllication of Feulgen technique, it was now clear that the nucleolus did not contain chromatin. On this basis, therefore, all the old theories which regarded the nucleolus as a store-house of chromatin of as a manufacturer of chromatin were disregarded. The application of these methods to the developing egg-cells of insects[11] has shown that what were originally regarded as chromatin nucleoli on the basis of Heidenhain staining remain uncoloured by Feulgen, showing that there was no transfer of chromatin from nucleolus to the chromosomes. It is more than likely that a re-examination of Selachian oogenesis will prove the same thing.

Having disposed of one important question regarding the chromatin nature of the nucleolus it became possible to go further. An extension of the staining reactions in the form of the employment of light-green as a counter-stain has been developed in Gates's laboratory[12,13,14] and an application of these methods has shown that a true nucleolus stains green. That light-green is specific for histones has been established by Metz[15] who made a histone preparation from sea-urchin sperm and found it staining intensely with green.

On the basis of this new staining method, Gates has been able to establish, mainly in plant material, the part the nucleolus plays in the mitotic cycle. "The nucleoli arise in telophase at a particular locus of the chromosomes, having a satellite or a secondary constriction. Each grows to a predetermined size and when any two nucleoli touch during this growth or through movements of the chromosomes within the nucleus, they merge, like two droplets into one. The process generally continues until before the following prophase a single large fusion nucleolus is present to which the chromosomes which produced the nucleoli will all be found attached at the loci of the origin of the original nucleoli. When the nuclear membrane breaks down in late prophase, the nucleolus generally becomes detached from the chromosomes and passes into the cytoplasm where it disappears."[5]

Far from the nucleolus contributing material to the chromosomes in the formation of the latter, it would appear that the nucleolus actually *receives* material from the chromosomes and transfers it back to the cytoplasm during every mitotic cycle. Staining reactions as well as examination by ultra-violet absorption spectroscopy, show that this material is not chromatin but is largely made up of protein with which nucleic acid of the ribose variety is often associated. Hence the confusion which was met with in the earlier stages of the history of our knowledge of the nucleolus. Hæmatoxylin is unable to differentiate between the two types of nucleic acid and the 'karyosomes' of Ogata[16] and the 'chromatin nucleolus' of Montgomery[17] must have been largely such accumulations of ribose nucleic acids in relation with protein. It is believed that in telophase, when the desoxyribose nucleic acid of the chromosomes is being reconverted into the ribose type, some of it, with the protein, must find its way into the nucleolus. In fact, it is assumed that to account for the growth of the nucleoli at the nucleolar organizers, "each acts as a sink or a sump at which the material aggregates". It is tempting to adopt the attractive hypothesis that in the transference of the nucleic acid from the nucleus to the cytoplasm the nucleolus plays an important part as a vehicle, receiving the excess protein and nucleic acid from the chromosomes and transferring it back to the cytoplasm during every mitosis,—a transference whose full significance is still obscure but which according to Gates, may be "a source of energy in the cell".

Whatever the functional significance of the nucleolus in the mitotic cycle, it is clear that it is a repository of simple types of proteins (histones) associated with ribose nucleic acid.

That is the picture so far as the majority of plants are concerned, where the relationship between the nucleolus and the chromosome has been established and where the part

played by the nucleolus in the protein and nucleic acid metabolism may be estimated with a reasonable amount of certainty. Unfortunately, however, in animal cells, this relationship between the chromosomes and the nucleolus has not been established with the same amount of unmistakable regularity. Only in the salivary gland nuclei of Diptera have the nucleoli an appreciably similar disposition. In *Chironomus*, where the nucleolus is extremely large, it is associated with the small chromosome IV. [18,19] It is important that in so far as animal cells are concerned, the nucleolus requires further study, not so much from its functional aspect, but from the aspect of its relation with the chromosomes.

The present position in regard to the nucleolus would be that it is largely composed of histone and ribose nucleic acid which it receives from the chromosomes during telophase and which later diffuses into the cytoplasm, where it stimulates the synthesis of proteins and other metabolic products. In fact, a definite connexion has been established between the size of the nucleolus and protein production, the nucleolus being largest in cells where rapid protein production is going on, and relatively small in cells where no protein is being made.[6]

In this connection, the study of the nucleolus of the Sertoli cells of the testis is full of interest. In his description of the cytology of the Sertoli cells in the testis of Apoda (Amphibia), one of us[20] noticed a number of nucleoli in the Sertoli nuclei, all taking up hæmatoxylin. Re-examination of these nucleoli and selective staining by Feulgen-light-green showed that the nucleolus (of *Siphonops annulatus*) was really a compound structure; the centre, a spherical body stained green, to the periphery of which were plastered a number of pink bodies. This picture of the nucleolus demanded a new orientation of our ideas of the nucleolus. Undoubtedly here we had a compound nucleolus with a central Feulgen negative sphere in which there was a preponderance of histone while the periphery was made up of a varying number of Feulgen positive bodies in which there was an accumulation of desoxyribose nucleic acid. The association of desoxyribose nucleic acid with histones in the nucleolus is an interesting discovery and is in our opinion, a visual demonstration of the truth of the association of the two components. Until now such an association between the desoxyribose nucleic acid and the histone in the chromosomes was only inferred by indirect methods such as have been recalled earlier. The fact of the association of the two demonstrated by staining technique adds precision to the picture.

It has, however, not been possible, in the Sertoli cells, to establish a connection between the nucleoli and the chromosomes. Sertoli cells are nutritive and supporting cells of the testis and mitoses in them are either rare or wanting. We have to regard them as cells which have attained a condition of permanent rest. Under the conditions, it is therefore impossible to establish a relationship between the chromosomes and the nucleoli. But the relatively large nucleolar content of Sertoli cells in the Apoda may be understood by the assumption of their importance in protein production but here we would like to be on surer ground before assuming the fundamentals of the behaviour of Sertoli cells. A systematic examination of different types of animal and plant cells is being made in these laboratories with a view to harmonizing our present divergent ideas regarding the origin and significance of nucleoli.

In this connexion, we would like to enter a strong plea for the provision in this country, of adequate equipment for modern methods of biological investigation. The wide possibilities opened up by ultra-violet absorption spectroscopy developed by Caspersson as long ago as 1934 or the immense advantages of the Electron microscope are denied to workers in India, and we would like to take this opportunity to urge on the premier Scientific Institutions and Societies, and the Governments in the country to make available these modern facilities for biological investigation.

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THE AGE OF MICROLITHIC CULTURE IN GUJARAT

By H. D. SANKALIA

WHILE reviewing our work, "The Second Gujarat Prehistoric Expedition in Search of Microlithic Man in Gujarat", it was said in *Nature*[1] that the microlithic industries in India were not older than the 2nd century B.C. and in no way comparable to the Mesolithic of Europe either culturally or in time.

Microliths have a very wide distribution in India. They have been found not only in the Mahadeo Hills, C.P., but, as Foote and subsequent investigators have shown, all along the southeast coast, in the Hyderabad and Mysore States, Central India, Gujarat, Kathiawar, Cutch, Sind and the Punjab. It would indeed be strange if in all these areas, some of which were the centres of highly advanced metal civilizations, at least from the 3rd century B.C. onwards, microliths were still used

as tools. The material culture—tools, weapons, etc.,—depicted in the sculptures at Amaravati, Nagarajunikonda, Bharhut, Sanchi and elsewhere as well as finds from the excavations at Kondapur, etc., indicate that much larger tools of metal were common. For a number of these areas, however, the question must remain open, until excavations reveal a stratigraphic sequence which will enable us to assign the microlithic industries to any definite period. Latterly such an evidence has been forthcoming from two areas for a prehistoric dating of the microlithic culture, and it is pointed out briefly in this note.

The evidence from Mahadeo Hill paintings discussed by Colonel Gordon[2] is not much helpful, for there is neither stratigraphic nor cultural relationship between the microliths and the rock-paintings. The former might be older, or contemporary with the paintings, which are themselves not of one period, but seem to extend over a thousand years. Very recently in the excavations at Brahmagiri in the Mysore State, Dr. M. H. Krishna[3] found microliths in association with neoliths in comparatively higher levels and *only* microliths in the lowest levels, the whole culture sequence including more than one stratum of iron age followed by the historic period attributed to the early centuries before Christ.

The Mahadeo Hill evidence may thus be regarded as exceptional and local and cannot constitute a rule for the dating of microlithic culture throughout India.

The latest evidence comes from the loess mounds at Langhnaj in Northern Gujarat, where digging has been in progress for the last three seasons. Here, as also in the small digging in the loess site at Hirpura, no metal objects have been found, as ordinarily they should have been, had the use of microliths survived as late as the 10th century A.D. Langhnaj along with many other localities in N. Gujarat was a flourishing village and has been in continuous occupation since then. These microlithic sites of N. Gujarat are not very far removed from the political and cultural centres throughout the historical period, while, as the Mahadeo Hill region is cut off from the main centres of civilization, we may assume there the survival of the Stone Age tradition to a later date. If the microliths at Langhnaj were so late as even the 2nd century B.C., some contemporary evidence in the shape of Indo-Greek or punch-marked coins, terrocottas, pottery, etc., should have been found along with the microliths.

So far we have discovered microliths and fossilized (calcified) skeletal remains after about 3 feet of digging in an unstratified loessic soil. These really constitute much more important evidence than the negative one. The juxtaposition and inter-relation in which these skeletons occur with animal remains, bone- and pebble-conglomerates, and microliths about the four-foot level, and the fact that human and animal remains are equally fossilized point to all of them being contemporaneous deposits. There is thus no ground to suppose that we have to deal with any but a prehistoric Stone Age culture.

The age of this microlithic culture in Gujarat rests largely on the degree of fossilization of our finds. Our studies on this point have so far been confined to ascertaining the exact nature of fossilization and its relative proportion to finds of old bones from preferably comparable deposits. On the latter point we find that bones discovered from historical sites, about 2,000 years old, are not at all fossilized; nor are the human and animal remains unearthed at Mohenjodaro and Harappa. Comparison with finds by Dr. De Terra[4] from an excavation in the upper loessic deposits at Uchali near Naushahra, in the Salt Range, Punjab is still more instructive. He found stray microliths and remains of *Homo sapiens* of dolicocephalic type and funerary pottery of handmade neolithic type. These remains were bleached and very brittle.[5] Such a poor state of preservation, as well as a general paucity of vertebrate fossil remains in the Potwar loess was attributed by De Terra to a high percentage of lime carbonate in the soil, which he considers really wind-borne silt, deposited in late Pleistocene to sub-recent times.

De Terra seems to be wrong in regarding the lime carbonate as destructive of bones. Usually it is believed to help compaction and mineralization. Many of the fossil remains in India and outside have been from limestone caves.

The mineral composition and chemical analysis of the Gujarat loess shows that it is almost of identical nature as the Potwar loess. It is in fact the alluvium of the Sabarmati and other rivers wafted back by wind and deposited all over the Gujarat plain as well as on high altitudes like the Taranga Hill. It contains a high percentage of lime, and a small proportion of the other constituents: magnesia, potash, phosphoric acid and nitrogen.

The present climatic conditions in N. Gujarat are not very much different from those in the N.W. Punjab. There are extremes of cold and heat, and periodic but not heavy rains. But unlike the Punjab, in the top soil of the loess we find human and animal remains which are not only highly calcified, but the proportion of fluorine to that of phosphoric acid is more than in the bones of the diluvian period in Europe. (Unfortunately, there is no data from India to compare with.) Like the Coldrum remains described by Sir Arthur Keith,[6] chalk has completely permeated the porous texture of the bones, there is a porcelain-like ring and the tongue adheres to the freshly fractured surface, showing that there is no organic animal matter left. And though, "there is no change of the nature of petrification or mineral replacement as in the true Siwalik mammalian fossils, still the change of the tissue" (says Mr. Wadia after kindly examining our specimens), "undergone by the bones, lying in a matrix of unconsolidated kaolin silt in the comparatively arid climate is sufficiently marked to give some index of their age".

We are, therefore, driven to the conclusion from

(1) the absence of metals,
(2) the paucity of pottery,

(3) the state of preservation of human and animal remains,

that the Gujarat microlithic culture is far older than that of Mohenjodaro. Of course, further evidence is necessary, and this may be had when detailed examination is made of animal remains, such as the exceptionally huge rib and shoulder blade, which appear to belong to certain animals, now extinct in Gujarat.

With regard to the comparison of the Gujarat microlithic culture with the European mesolithic or early neolithic there is no stratigraphic evidence yet available, except the meagre data from Mysore. However, attention may be drawn to certain features ... such as roundish pierced hammer-stone or mace-head with the hole splayed from above and below,, bone tools, absence of pottery, etc. ... of the Gujarat microlithic culture which can be compared to the European microlithic culture, without implying culture contact or even contemporary in time.

1. *Nature*, March 31, 1945, p. 386, *cf.* also *Nature* February 10 1945, p. 185. 2. *Indian Art and Letters*, 1936, pp. 35–41. 3. Presidential Address, Section of Anthropology, 29th *Science Congress*, Baroda, 1942. 4. *Studies on the Ice Age in India and Associated Human Cultures*, pp. 275-78. 5. Even the remains of sub-recent fossil horse, dog, camel, and bovid discovered by Mr. D. N. Wadia, were, as he kindly informs me, very friable and difficult to extract from the ground. 6. Antiquity of Man, Vol. I, 9. 8.

THE OCCURRENCE OF *PARROTIA JACQUEMONTIANA* DCNE. IN THE PLEISTOCENE OF KASHMIR

BY G. S. PURI, M.SC., PH.D.

INTRODUCTION

AMONG the photographs of the Karewa fossils sent by Dr. R. R. Stewart to Dr. H. de Terra in 1938 and later published by the latter in his memoir (see de Terra and Paterson, 1939, pls. 53, 54), one photograph (loc. cit., pl. 53, fig. 3) illustrating two leaves of *Parrotia Jacquemontiana* Dcne., was reproduced under an incorrect name of *Quercus dilatata* Lindl. It may be recalled that Dr. Stewart under whom the author was working during 1937-1939 on de Terra's collections from the Karewa (Pleistone) deposits of Kashmir (Puri, 1939), sent to de Terra at his request twenty photographs and a preliminary list of the fossil species, so far identified by me, to show that the work on this material is in an advanced stage. But these photographs, together with the incomplete list of species, were published by de Terra in his above-quoted memoir (Puri, 1940), without any reference to me. The object of this note is to illustrate and briefly describe for the first time the fossils hitherto referred to *Quercus dilatata*, under the correct name of *Parrotia Jacquemontiana*, a large Himalayan shrub of the Celastraceæ.

DESCRIPTION

Parrotia Jacquemontiana Dcne.

The fossil leaves (attached to a twig) illustreated in Fig. 1 were collected by Dr. H. de Terra, the leader of the Karakoram Expedition to India in 1932, from the Karewa deposits, exposed in a stream-bed, near Liddarmarg (alt. 10,600 ft.; lat. 33° 48'; long. 74° 39'), a temporary encampment of Kashmiri shepherds, on the northern slopes of the Pir Panjal Range. The leaves, which were embedded in a blackish-grey clay, that splits fairly neatly along bedding planes, are rather poorly preserved and do not show finer details of venation. The leaf-lamina, which is somewhat obovate or nearly oblong in outline, is narrowed at the base and has an acute apex. The margins are irregularly and sharply toothed.

The venation is strict-pinnate and reticulate, it consists of a fairly broad midrib and 5-7 pairs of secondaries, which are about half as thick as the midrib, and diverge in an alternate manner at angles varying from acute to slightly abtuse. Some of the laterals bifurcate near the margins. The tertiary and finer reticulations are not well preserved but such

FIG. 1

as can be seen resemble closely those of living leaves of this species (Fig. 2). Organic matter of the leaf, too badly cracked to yield a good cuticular preparation, is present in both the leaves.

In shape, size, margins and details of venation our fossils are identical with *Parrotia Jaquemontiana* Dcne. (Fig. 2), a large shrub of the Western Himalayas. They are altogether different from *Quercus dialatata* (Fig. 3), under which they were placed by de Terra apparently by a mistake.

Number of specimens: Two only.
Occurrence: Liddarmarg, at 10,600 ft., Pir Panjal Range, Kashmir.
Collector: H. de Terra, 1932.
Reg. No. of figured specimen: Loc. 3L 36.

FIG. 2

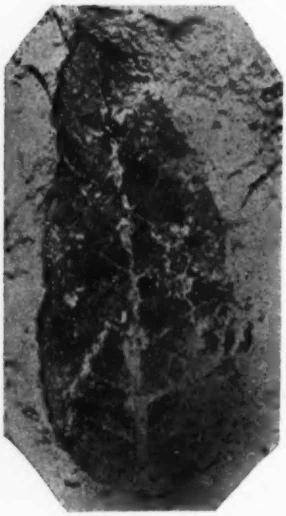

FIG. 3

MODERN DISTRIBUTION OF THE SPECIES

Parrotia Jacquemontiana, popularly known as the "Himalayan witch-hazel", is a large deciduous shrub of the Western Himalayas, which grows in mountainous country, westwards from Jumna, at the altitudes of 3,000 to 8,500 ft. In the Kashmir Himalayas, especially towards the eastern end of the valley, it is gregarious in forests of *Cedrus deodara*.

In the moist deodar forests of the Kagan Valley in Hazara, *Parrotia Jacquemontiana*, which is very abundant, occurs in association with *Viburnum nervosum* under a canopy of *Cedrus Deodora, Pinus excelsa* and *Quercus dilatata*. Similar forests with *Parrotia* forming a thick undergrowth occur on drier aspects in the Chamba and Baspa Valleys, but in the Murree Hills, it prefers moist localities. According to Champion (1936, p. 240) the Kagan Valley forest "is typical of forests in which the tall shrub *Parrotia* forms a dense undergrowth unfavourable for deodar generation". On the northern slopes of the Pir Panjal Range, where *Cedrus* forests are already so poorly represented Sher Singh (1929) considers *Parrotia* "a dangerous competitor of deodar in wet places". The same author while explaining the absence of deodar forests from the northern slopes of the Pir Panjal remarks that a high humidity resulting from a greater snow-fall in these regions creates unfavourable conditions for the growth of deodar. This contention of Sher Singh finds support from the fossil evidence, which I propose to discus elsewhere.

In the dry temperate mixed evergreen forests of Kilba, Upper Bashahr Division, *Parrotia Jacquemontiana* occurs in association with *Rhus succedanea, Olea cuspidata, Zanthoxylum alatum, Artemisia maritima, A. vulgaris, Daphne oleoides, Rosa Webbiana, Berberis* spp., *Lonicera angustifolia, Abelia triflora, Sophora mollis, Celtis australis, Acer pentapomicum, Quercus, Ilex, Cedrus Deodara* and *Pinus gerardiana* (Champion, *loc. cit.*, p. 254).

The Kashmir distribution of the species with which we are specially concerned is chiefly restricted to the valley proper where shrubby plants of *Parrotia* ascend to an altitude of about 6,500 ft. on the Pir Panjal.

The wood of this shrub in Kashmir is said to possess certain miraculous properties; sticks of *Parrotia* are often found in the hands of Kashmiri hill-tribes men to guard them against snakes, which are believed to be repelled by an aroma coming out of its wood.

CONCLUSIONS

A comparison of the past and present distribution of the species provides further evidence in favour of the theory that the Kashmir Himalayas have been uplifted by at least 5,000 to 6,000 feet after the deposition of the Karewa lake beds (see Puri, 1943, 1945, 1945*a*, 1946) at the level of the valley (about 5,200 ft.). These youngest deposits of the valley were bodily dragged by the Pleistone orogeniec on the neighbouring mountains where they lie tilted, sloping towards the valley, being unconformably overlain on the solid bed-rock.

The testimony of other fossil species, which have been discovered from this locality also points in the same direction (Puri, 1943, 1945, 1945*a*).

In the end, I wish to record my indebtedness to Prof. B. Sahni, F.R.S., for helpful criticism.

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TECHNIQUES IN THE STUDY OF NUCLEAR FISSION*

BY

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THIS note gives an account of the different experimental techniques that have been employed so far in the study of the phenomenon of the fission of the atomic nucleus.

Soon after Hahn and Strassmann[1] announced in the columns of *Naturwissenschaften* of January 1939, their discovery of the possible splitting of the uranium atomic nucleus by the entry of a neutron, studies of the phenomenon were taken up at Copenhagen, Paris, Washington, Princeton, Baltimore and San Francisco. Measurements of the energy release with an ionisation chamber coupled to a linear pulse amplifier and an electro-mechanical oscillograph[2] gave a value of about 100 Mev. for the lighter fragment and about 75 Mev. for the heavier one. Wilson expansion chamber studies gave a value of about 22 mm. for the range of fragments in ordinary air. Expansion chamber studies[4] in Bohr's laboratory at Copenhagen show that the tracks have features characteristic of the big charge and heavy mass of the fragments. Chemical analysis of the fission products, notably in the hands of Lise Meitner, has led to the identification of about 100 different radioactive isotopes belonging to 25 different elements. Since chemical methods of separation are unable to identify short-lived products and since the splitting of the nucleus takes place in different ways—a feature well brought out in the comprehensive theory of nuclear fission developed by Bohr and Wheeler,[6] chemical investigations do not directly reveal the formation of two complementary primary fission fragments.

Frisch was the first to point out that the big mass and charge of the fragments will give rise to an intense ionisation along their paths. About 3 million ion pairs are formed along the track of each fragment and the charge delivered to the collecting electrode in the ionisation chamber is about 5×10^{-13} coulomb. Frisch[7] used 300 mg. of radium bromide mixed with beryllium powder, for the source of neutrons. When the ionisation chamber was lined with uranium oxide on its inner surface, only about 30 fission counts per minute were observed, while one millicurie of a Rn-Be source is estimated to emit 15,000 neutrons per second. Experiments similar to that of Frisch have been carried out[8] in U.S.A. using the Van de Graaf generator or the cyclotron and the Be-D, Li-D or the D-D nuclear reaction for the generation of neutrons. Although the electrostatic generator does not give an accelerated ion current comparable with that of the cyclotron, it gives a steadier voltage.[9] The beryllium deuteron nuclear reaction gives the richest yield of neutrons. The Li-D reaction gives neutrons of 13·5 Mev. maximum kinetic energy and the D-D reaction using a heavy ice target 2·5 Mev. mono-kinetic neutrons. The neutron intensity with 1,000 KV. one micro-ampere deuteron current bombarding beryllium is estimated to correspond to that from 10,000 millicuries of radon-beryllium. To measure the efficiency of slow neutrons as compared with that of fast ones, in brining about fission, the ionisation or the expansion chamber, enclosing the irradiated uranium layer, and in some cases the neutron source as well, and surrounded by a block of paraffin. It is found that neutrons of energy between 0·5 and 2·5 Mev. are most effective in producing fission and the cross-section is estimated to be about 2×10^{-24} cms.[2]

Zinn and Szilard[10] studied the emission of *fast* neutrons from uranium when irradiated by *slow* neutrons, the source being a radium-beryllium photo-neutron source embedded in a paraffin block. The fast neutrons were detected by an ionisation chamber filled with helium and the interspace between the neutron source and the chamber contained thick layers of lead and uranium. Fermi and his co-workers at the Columbia University[11] used a different experimental arrangement. A Rn-Be source of neutrons was placed at the centre of a 13 cm. diameter spherical bulb, immersed in a tank of water to slow down the neutrons. The induced beta-activity on a rhodium metal foil placed at different distances from the source of neutrons was measured with and without uranium oxide inside the bulb. From the measured variation in the induced activity of the foil and the geometry of the experimental arrangement, the average number of secondary neutrons was estimated to be nearly two. Joliot and his co-workers[12] find a value of $3 \cdot 5 \pm 0 \cdot 7$ neutrons per fission, from their experiments.

Lise Meitner was the first to point out that the recoil phenomenon may be used for the separation of the fission products. This method has been used by a number of investigators to isolate and study the radioactivity of the products.[13] If a stalk of cellophane foils of suitable thickness is placed close to the fissuring layer at different distances from it, the different groups of fission products can be collected and their beta-activity studied by wrapping the foils around thin-walled Geiger-Muller counters. If the neutron irradiation is carried out for a considerable time,—30 to 60 minutes when the cyclotron is used,—the collected products on the foils can be analysed for their chemical identification. In her latest experiment, in Siegbahn's laboratory, Lise Meitner[14] places the foils and the uranium-coated plate inside the dee-chamber of the cyclotron. To study the H-distribution by deflecting the fission fragments in the magnetic field of the cyclotron itself, Lassen,[15] working in Bohr's laboratory at Copenhagen, places the ionisation

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* Based on a talk given by one of the authors (C. K. S.) at the Discussion on "Nuclear Fission" in the Physics Section of the Indian Science Congress Session (2nd to 8th Jan. 1946), at Bangalore.

chamber also inside the dees of the cyclotron. tron.

1. Hahn and Strassmann, *Naturwiss*, 1939, **27**, 16. 2. Roberts, *et. al. Phy. Rev.*, 1939, **55**, 416; Anderson, *et. al.. Ibid* 797. 3. Joliot, *C. R.*, 1939, **208**, 647. 4. Bo gild, *et. al.*, *Phy. Rev.*, 1941. **59**. 275. 5. Thibaud and Moussa, *C. R.*, 1939, **208**, 642. 6. Bohr and Wheeler. *Phy. Rev.*, 1939, **56**, 426; 1065. 7. Frisch, *Nature.*, 1939, **143**, 852. 8. Kanner and Barschall, *Phy. Rev.*, 1940 **57**, 372. 9. Sundaracbar, Streib, and Raghavendra Rao., *Curr. Sci.*, 1941, **10**. 124. 10. Zinn and Szilard, *Phy. Rev.*. 1939, **55**, 619 11 Anderson, H.L., Fermi and Hanstein., *Phy. Rev.*, 1939, **55**, 797. 12. H. von Halban, Joliot and Kowarski, *Nature*, 1939, **143**, 680. 13. Joliot, *C. R.*, 1939, **208**, 341; Segre., *Phy. Rev.*, 1939 **55**, 1104. 14. Lise Meitner, *Rev. Mod. Phy*, (Bohr Number) April–July 1945, p. 287s 15. Lassen, E. O., *Phy Rev.*, 1945, **68**, 142.

STATISTICS AND NATIONAL PLANNING*

STATISTICAL SCIENCE, after passing through several stages of neglect and pseudo-scientific activity, has now well established itself into the very fabric of our thought. In a diversity of scientific fields the foundations are those laid on observations and statistics, and the technique is the logic which enables the measurement of essential factors to be made simultaneously from a number of different angles and assumes the probability basis. In business and industry, statistical research has now gone beyond market problems to the determination of consumption patterns and the setting up of standards and of quality control in production. Governments, however, are the largest creators, preservers and sometimes destroyers of statistical information. National disasters, wars, famines, pestilences and now, reconstruction planning have forced Governments to adopt new and quick methods for obtaining facts and to adopt policies suggested by them. In these essential requirements Statisticians have, in spite of many handicaps, played an important role in recent years.

The most remarkable development from the point of view of administrations is the confidence now being placed in the suitability of the method of investigation by sample. A large number of schemes for ascertaining the several facets of economic life of the country, such as cost of living, variations in employment, vilume of postal transactions, traffic density, etc., are now operated on the sample method. The failure to proceed with full tabulation at the census of 1941 had left this country without the basic information of age, sex and civic condition of the people which are essential for scientifically estimating the growth of population. Prof. Madhava, who worked on a Committee of Government which investigated the characteristics of sample slips that had been preserved under orders of the Census Commissioner, reported that satisfactory age tables, life tables and projections can be obtained on the basis of the sample slips. Such a means of repairing the lacuna that had been created was of obvious significance when it is realised that in the final analysis planning has to be based for people in relation to their numbers, their distribution, their ages and their means of livelihood. In food planning too, the weightage to be given to persons according to their ages in the consumption of different articles of food was a basic requirement. Traffic density and the capacity of several economic factors to contribute to traffic were foundations on which plans for the development of communications and transport had to be based. Professor Madhava gave an account of his recent work in these directions and observed that no planning was possible or sensible, without first planning for facts.

Recent opportunities for the extension of statistcial work had brought to light the acute shortage of suitably trained persons and the paucity of college teachers who had sufficient profundity and versatility to cover every conceivable application of such a method. The most rapid way of remedying these defects was through the development of independent statistical schools in Indian universities, and through industrial laboratories and non-official institutes which would give, through their project work, training not only in technical work but in field work and computation also. Statistical work was rapidly developing as a professional service, and in due course questions concerning recruitment, classification and the placing of statisticians in Government, industry and the professions would become live issues. Professor Madhava pleaded for frequent contacts and interchange of views amongst statisticians and others in this country and outside.

* Abstract of Prof. K. B. Madhava's Presidential Address to the Section of Statistics, Indian Science Congress. Bangalore, 1946.

ELASTIC CONSTANTS OF CRYSTALS*

PROF. BHAGAVANTAM has described a new method for measuring the elastic constants of materials available in the shape of small plates. Wedge-shaped sections cut from piezo-electric crystals, such as quartz or tourmaline, are used for generating ultrasonic waves by employing them in high frequency oscillatory circuits of the standard type. As the exciting frequency of the electrical circuit is varied, an appropriate portion of the wedge responds to the electrical frequency and thus it becomes possible to obtain a continuous band of ultrasonic frequencies, the width of the band depending upon the dimensions of the wedge. By using two or three such wedges, an appreciable range, say one to fifteen megacycles per second, may be covered. When one of the oscillating wedges is laid on a crystal plate or a plate or a plate cut out of an isotropic material, sound waves of certain chosen frequencies are transmitted with maximum intensities. This fact of favoured transmission is detected by allowing the transmitted wave to get into a liquid and form a grating which is used in the usual type of optical arrangement for producing the Debye-Sears diffraction patterns. The frequencies corresponding to such trans-

* Summary of the Presidential Address delivered by Prof. S. Bhagavantam, before the Section of Physics Indian Science Congress, Bangalore, 1946.

mission maxima are measured with an accurate wave meter and the corresponding sound velocities in the material calculated from its known thickness. In general, there are three sound velocities associated with any thickness direction for a material and they are related to the elastic constants or linear combinations of them in a manner that may be determined in each case by taking into consideration the symmetry of the crystal and the orientation of the plate chosen for investigation. In the simplest case, namely, that of an isotropic substance, two of the velocities coincide and lead to the rigidity modulus and the third one which is distinct leads to the Young's modulus. Relationships in crystals are more complicated.

This method has been developed in detail and the individual elastic constants of diamond measured for the first time. The merit of the newly developed method lies in its wide scope as may be seen from the fact that a substance like diamond, small sections of which only can be made available for experimental purposes, has lent itself for study. Zinc-blende, galena, iron pyrites, rock-salt, apatite, quartz, calcite and sodium nitrate are amongst the other substances studied. The theoretical significance of the results in general and their relationship to the spectroscopic data in particular have been discussed. Such studies may be extended to solving other problems of fundamental interest and as an example is mentioned the case of mixed crystals. Results obtained with seven different specimens of garnets collected from different parts of India are given and some of their features noted.

The method is also capable of being extended for the purpose of studying certain problems which were not within the reach of the older and already familiar technique of measuring elastic constants. A suggested line of investigation relates to the effect of temperature and of electric and magnetic fields on the elastic constants of different materials.

BOTANY AND HUMAN WELFARE*

PLANT introduction on a systematic and extensive scale followed by subsequent breeding plays a very important role in the improvement of the desired strain. Wild or semi-wild varieties could be incorporated in the commercially cultivated varieties of crop plants by hybridisation in order to overcome many of the most pressing problems of crop production. Improvement of potato by a recombination of the genes of the wild and cultivated species and varieties through hybridisation has been a bright programme in America. Introduction followed by subsequent breeding has been responsible for the varieties on which the American-Egyptian extra-long staple cotton industry is based. Similar methods preserved the Java sugarcane which would otherwise have become extinct. The establishment of a Bureau of Plant Introduction in India on the lines of those in America and Russia is long overdue.

Breeding has been the widest application in India. After selecting the high-yielding plants and discarding the others, further progress is possible by the method of hybridisation. Extensive work along these lines conducted by the Agricultural Research Institute have reculted in the famous Pusa 4 and Pusa 12 wheats and have demonstrated that there exist Indian wheats which are equal in quality to good Manitoba wheat. Existing improved wheats are good yielders, give grain of excellent quality and have good standing power. The importance of evolving a variety which possesses all these qualities together with a resistance to the attack of rusts cannot be denied. When once such a variety is grown in the hills, the chances of infection in the plains would be reduced, apart from the value of such wheats to the hill farmers themselves. A programme to reach the target has been initiated in two stages: (1) breeding of varieties resistant to the black, brown and yellow rusts respectively and (2) synthesis of further varieties embracing resistance to all the three rusts simultaneously. As none of the indigenous varieties tested possessed much resistance (excepting Pusa 120), hybridisation with exotic varieties which were virtually immune to the rusts was adopted. Now varieties respectively resistant to all the races of yellow and brown rusts have been built up and varieties resistant to all the Indian races of black rust too are expected to be obtained shortly.

Unlike the position with regard to rusts, fortunately India possesses several good wheats which have a high resistance to smut and further breeding work is necessary to evolve a smut-resistant wheat. There is also a need for varieties which can give good crop of ripe grain with a minimum quantity of water, a programme towards which has been started recently.

In out-pollinating crops like maize, *bajra*, *Brassicæ*, cabbage, etc., single plant selection is impossible. Heterosis, which usually results on crossing two inbreds, and the standardisation of breeding technique has revolutionised maize production in America. About the year 1920 double crosses were obtained which were more adaptable and less susceptible to adverse conditions of growth. Such commercial hybrids yielded 40 per cent. more over the standard varieties. In addition they were uniform and more able to withstand draught, wind, disease, etc., than the best open pollinated varieties. In India no serious attempts have so far been made to exploit hybrid vigour.

Vegetatively-propagated plants, grasses and forage crops, vegetables, fruits and forest trees have not received any methods of improvement in India. The importance of evolving disease-resistant varieties, in spite of the several precautionary or remedying measures under practice, becomes exemplified in a country like India where the average farmer is too poor to be able to afford the cost of spraying and dusting.

In India vernalisation would be of value only in regions where special conditions prevail which render the growing of crops a precarious operation. The direct application of vernalisation to agriculture does not appear to hold much promise; it is, however, of great value in the speeding up of plant breeding. Introduction of and research on growth-hormones is full of possibilities for the future. Hydroponics does not give promise of immediate application to agriculture.

B. G. L. S.

* Abstract of Dr. B. P. Paul's Presidential Address to the Section of Botany, Indian Science Congress, Bangalore, 1946.

LETTERS TO THE EDITOR

A PECULIAR GAP-FILLING PROCESS FOR POWERS OF $(9)_n$

IN the *B.U.J.*,* Mr. Kaprekar has considered a few examples in the gap-filling process for powers of $(9)_n$. In that note, he has taken powers only upto 5. In this note, I establish a method for the gap-filling process whatever be the power. Moreover in this method, we need not calculate the value of the different powers of 9, which are necessary in Mr. Kaprekar's method.

Notations.—(1) $(9)_n$ stands for the digit 9 repeated n times and $(9)^k{}_n$ stands for the k^{th} power of $(9)_n$.

(2) p is defined by the relation,

$$10^{p-1} < {}^kC_r \leqslant 10^p, \text{ where } r = \frac{k}{2} \text{ if } k \text{ is even,}$$

$$\text{and } = \frac{k-1}{2} \text{ if } k \text{ is odd.}$$

(3) k and n are positive integers and $n \geqslant p$.

(4) When we call (x) a p digit number; if x does not contain p digits. we mean that the necessary number of zeros are prefixed to x so as to make it a p digit number. *e.g.*, if $p = 3$ and $x = 35$, we take $(x) = (035)$.

With these notations we will show that $(9)_n{}^k = \ldots\ldots(10^p - {}^kC_1) \ldots\ldots ({}^kC_2 - 1)\ldots\ldots (10^p - {}^kC_3)\ldots\ldots({}^kC_4 - 1)\ldots\ldots$ where $(10^p - {}^kC_1)$, $({}^kC_2 - 1)$ etc., are all p digit numbers and the gaps from left to right are filled in by $(9)_{n-p}$ and $(0)_{n-p}$ alternately, thus making it

$$= (9)_{n-p}(10^p - {}^kC_1)(0)_{n-p}({}^kC_2 - 1)(9)_{n-p}(10^p - {}^kC_3)(0)_{n-p}({}^kC_4 - 1).$$

The last p digits being by ${}^kC_k$ or $(10^p - {}^kC_k)$ according as k is even or odd.

Proof.—$(9)_n{}^k = (10^n - 1)^k$

$$= 10^{nk} - {}^kC_1 \cdot 10^{n(k-1)} + {}^kC_2 \cdot 10^{n(k-2)} - {}^kC_3 \cdot 10^{n(k-3)} + \ldots$$

$$= [10^n - {}^kC_1] \cdot 10^{n(k-1)} + [{}^kC_2\, 10^n - {}^kC_3] \cdot 10^{n(k-3)} + \ldots$$

$$= [(9)_{n-p}\, 10^p + (10^p - {}^kC_1)] \cdot 10^{n(k-1)} + [({}^kC_2 - 1)\cdot 10^n + (9)_{n-p}\, 10^p + (10^p - {}^kC_3)] \cdot 10^{n(k-3)} \ldots$$

since $10^n - 10^p = (9)_{n-p} \cdot 10^p$

$$= [(9)_{n-p} \cdot (10^p - {}^kC_1)]\, 10^{n(k-1)} + [({}^kC_{2-1})\, (9)_{n-p}\, (10^p - {}^kC_3)]\, 10^{n(k-3)} + \ldots$$

since $(10^p - {}^kC_1)$ etc are p digit numbers.

$$= (9)_{n-p}\, (10^p - {}^kC_1) \cdot (0)_{n-p}\, ({}^kC_2 - 1)\, (9)_{n-p}\, (10^p - {}^kC_3) \ldots$$

$$= \ldots (10^p - {}^kC_1) \ldots ({}^kC_2 - 1) \ldots (10^p - {}^kC_3) \ldots ({}^kC_4 - 1) \ldots,$$

where $(10^p - {}^kC_1)$, $({}^kC_2 - 1)$, etc., are p digit numbers; and the gaps are filled in with $(9)_{n-p}$ and $(0)_{n-p}$ alternately.

When $k \leqslant 5$. $p = 1$ and so the problem is simple.

Ex.—$(9)_4{}^5 = -5-9-0-4-9$ to be filled in by $(9)_3$ and $(0)_3$ alternately $= 999\,5\,000\,9\,999\,0\,000\,4\,9999$.

We find that

$p=1$ if $k \leqslant 5$ $\quad$ $p=2$ if $6 \leqslant k \leqslant 8$

$p=3$ if $9 \leqslant k \leqslant 12$ $\quad$ $p=4$ if $13 \leqslant k \leqslant 15$

$p=5$ if $16 \leqslant k \leqslant 19$ $\quad$ $p=6$ if $20 \leqslant k \leqslant 22$.

Note.—Whatever be the value of n $(> p)$ to write down $(9)_n{}^k$, we have to calculate ${}^kC_1$, ${}^kC_2 \ldots {}^kC_k$ only.

Trivandrum, *August* 29, 1945. S. PARAMESWARAN.

* *Bombay University Journal*, March 1945.

THE EFFECT OF COLOUR ON THE VISUAL OBSERVATION OF LONG-PERIOD VARIABLE STARS

THE part played by colour in the errors involved in the visual observation of long-period variables was pointed out by Ford.[1] In order to verify the linear relationship between colour and mean deviation as derived by him, a study of twenty stars of varying colour was made utilising the same methods of analysis. The observational data were taken from the A.A.V.S.O. Reports in *Harvard Annals*, Vol. 107, Nos. 7 and 8, and Vol. 110, Nos. 1, 5, 6, 7 and 8. The deviations for each individual

observer were calculated for each night and a standard deviation σ_m for each star was computed by adopting the formula

$$\sigma_m = \sqrt{\frac{\Sigma \delta^2}{N}}, \qquad (1)$$

where $\Sigma\, \delta^2$ is the sum of the squares of the deviations, and N the total number of observations made. Due to the uncertainty of the colour indices of long-period variables the Orthoff colour scale[2] used on A.A.V.S.O. charts was employed.

In Table I, the results are given.

TABLE I

No.	Design	Name of Star	Colour	σ_m
1	*053005a*	T. Orj.	0·0	0·36
2	123307	R. Vir	1·3	0·18
3	103769	R. Uma	1·6	0·27
4	115158	Z. Uma	2·0	0·24
5	123160	T. Uma	2·0	0·23
6	181136	W. Lyr	3·0	0·32
7	123961	S. Uma	3·2	0·30
8	142539a	V. Boo	3·6	0·32
9	*233815*	R. Aqr	4·3	0·27
10	024356	W. Per	4·9	0·30
11	*021403*	O Cet	5·0	0·27
12	021558	S. Per	5·0	0·22
13	193449	R Cyg	6·0	0·29
14	162119	U. Her	6·5	0·29
15	*162112*	V. Oph	6·6	0·24
16	094211	R. Leo	6·9	0·28
17	054920a	U. Ori	7·0	0·32
18	001755	T. Cas	7·3	0·32
19	201647	U. Cyg	8·4	0·32
20	200938	RS. Cyg	10·0	0·31

Fig. 1 shows the correlation between colour and σ_m for which a relation

$$\sigma_m = 0{\cdot}0124\,C + 0{\cdot}2157 \qquad (2)$$

was derived.

Ford's relation

$$\sigma_n = 0{\cdot}0205\,C + 0{\cdot}176 \qquad (3)$$

can be seen to differ considerably from the new relations derived. The notation σ_m in equation (2) indicates a standard deviation in magnitudes, and C is the colour on the Orthoff scale.

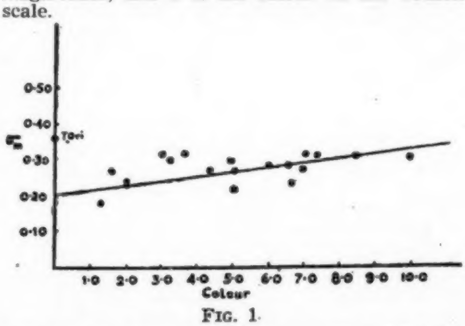

FIG. 1

It can be seen from Fig. 1, that T. Orionis 053005 *a* has an unusually high error which can be explained as due to the Dove effect.[3]

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1. *Pop. Astr.*, **43**, 9. 2. *A. N.*, 1900, **153**, 141 1912, **192**, p. 85. 3. Furness, *Introduction to the stud(of Variable Stars*.

LIGHT-SCATTERING IN AQUEOUS TIMBER WOOD EXTRACTS

THERE are immense possibilities, as one of the authors has pointed out some time ago,[1] for the application of the method of light-scattering to the solution of problems in several fields of scientific investigation. One such problem is that of Identification of Timber Woods. The only optical work so far carried out in this connection is by Shah and Singh,[2] who have recently studied the absorption spectra of some aqueous timber wood extracts. They arrive at the qualitative result that the spectra for the different extracts they investigated are very dissimilar. A study of the factors of depolarisation of the light transversely scattered in aqueous timber wood extracts is capable of yielding reproducible and characteristic values for each specimen and would also throw valuable light on the state of dispersion in the medium of the scattering elements.

Five important timber woods from amongst those commonly used to make furniture were chosen for the present work. They are: (1) Teak wood (*Tectona grandis*), (2) Red cedar (*Eugenia manogynum*), (3) Chittagong wood (*Chikrassia tabularis*), (4) Moulmein cedar (*Cedrella toona*) and (5) Rose wood (*Dalbergia latifolia*). Fine shavings of these specimens were obtained by planing and kept inside a desiccator for three days. The extracts were prepared by boiling 2 gms. of the dried shavings with 150 c.c. of pure distilled water for ten minutes. They were then rendered mote-free by filtration through a few layers ash-free filter-paper and transferred into spherical resistance glass flasks. The depolarisation factors ρ_u, ρ_v and ρ_h, with the incident light respectvely unpolarised and vertically and horizontally polarised,[3] were determined by the usual Cornu method. Suitable precautions were taken to eliminate or minimise all the incidental sources of error.

The results of the investigation are given in Table I. $\Delta\rho_u$ in the last column of this table

TABLE I

Extract	ρ_h %		ρ_u %	ρ_v %	$\Delta\rho_u$ %
	Observed	Calculated			
Rose wood	11	15	7·1	0·95	5·2
Red ceder	36	34	8·6	2·2	5·2
Teak wood	32	37	6·2	1·7	2·8
Moulmein cedar	39	41	5·1	1·5	2·2
Chittagong wood	59	63	8·2	3·3	1·8

is the difference between the observed value of ρ_u and the anisotropic part of ~~pu~~ ρ_u which may, to a first approximation, be considered as equal to $2\rho_v(1 + \rho_v)$. This is a function of the size of the scattering centre.[4]

From an analysis of these results, the following significant conclusions can be drawn :—

(1) The appreciable departure of ρ_h from the normal value of unity[5] shows that all these extracts are colloids. This was verified by the fact that coagulation could be brought about in all these extracts by the introduction of a few drops of a suitable electrolyte.

(2) The values of ρ_u and ρ_v are unique in each case and can be relied upon for the identification of the respective timber woods. The experiments were repeated three times under similar conditions with differnt specimens of the same species of timber wood and the results were found to be substantially the same as above.

(3) $\Delta\rho_u$ and ρ_v, which may respectively be taken as indicative of the size and anisotropy of the elements of optical inhomogeneity, are different for the different extracts.

It is interesting to note from Table I that the scattering elements in rose wood sol, which have the largest relative size, seem to have the least relative anisotropy; while those in the Chittagong wood sol, which have the least relative size, show the maximum relative anisotropy.

Further investigations with non-aqueous and saturated extracts of different timber woods are in progress.

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1. Venkateswara Rao, D., *The Ceded Districts College Magazine*, 1942, **15**, 1–7. 2. (Miss) Shah, R., and Singh, T. C. N., *Curr. Sci.*, 1944, **13**, 178–79. 3. Krishnan, R. S., *Proc. Ind. Acad. Sci.*, (A), 1935, **1**, 915–27. 4. Krishnan, R. S., and Venkata Rao, P. *Ibid.*, 1944, **20**, 109–16. 5. Venkateswara Rao, D., *Ibid.*, 1942, **15**, 24-34.

SELECTIVE EXCITATION OF SPECTRA BY HIGH-FREQUENCY DISCHARGE

A SERIES of interesting observations about the selective excitation of spectra in discharge tubes by the high frequency oscillations have already been reported[1,2,3] and some of them also explained in terms of the excitation function[4,5] of the initial levels involved. From a H-type of discharge tube containing helium and mercury it is found that by varying the frequency of oscillations and using internal or external electrodes we may excite either mostly helium or mostly mercury. For certain frequencies of oscillations the glow remains in the broader portion of the tube and is greenish in colour containing mostly mercury and for other frequencies of oscillations the glow passes through the capillary, connecting the two broader portions and is greyish red containing mostly helium. The high frequency circuit used is of the Hartley type of the range from 200 metres to 500 metres of wavelength of oscillation. The coupling used in this case seems to be of the loose type, so that the maximum glow is obtained for two positions of the variable condenser.

Some other discharge tubes of the straight type, one containing hydrogen, the other helium with a trace of neon and a third containing neon only have been excited by the same circuit and a detailed investigation made within this range in the visible region by the constant deviation spectroscope. In all these cases separately taken there does not seem to be any relative change of intensity in the lines and the bands of the same spectrum, though there is a general change in the intensity of the spectrum as a whole. In the case of hydrogen the triplet bands seem to be more prominent in intensity at all the frequencies as compared to the singlet system. The energy available in the circuit seems to be of the order of 10 e.v. to 18 e.v.

These phenomena seem to be understandable in terms of the excitation functions of the initial levels and the mechanism of the wireless circuit used. The details will be published elsewhere.

My thanks are due to Dr. R. K. Asundi, Benares Hindu University, for guidance in the work.

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December 3, 1945.

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TAMARIND SEED "PECTIN"

WE read with interest the note on the above subject by Ghose and Krishna (1945);[1] we were particularly interested in the statement that they "have not been able to get *l. arabinose* amongst the products of hydrolysis or repeat the other data reported by Damodaran and Rangachari (1945).[2]" The "other data" referred to were: (*i*) tamarind seed when analysed for pectin according to Carré and Haynes (1922)[3] gave no calcium pectate; (*ii*) analysis for methoxyl and uronic acid gave extremely low values compared to genuine pectin; (*iii*) no galacturonic acid could be isolated from the product after acid hydrolysis; (*iv*) on the contrary, the hydrolysate consisted of a mixture of pentose and hexose sugars which were quantitatively estimated and in which *glucose* and *arabinose* were identified.

To compare these data with those obtained by Ghose and Krishna (1945)[1]: (*i*) no estimation of pectin by the standard method appears to have been made by them although this would have been the simplest method of

ascertaining if the substance they were dealing with was pectin; (*ii*) while we obtained values for methoxyl and uronic acid that were *too low* for pectin, Ghose and Krishna found *no* methoxyl or uronic acid (although some unknown acid grouping must be present in their preparation as they speak of a "very low acid number"); (*iii*) like us they failed to obtain any galacturonic acid on hydrolysis; (*iv*) as in our experiments their acid hydrolysate contained a mixture of hexose and pentose in which they identified *glucose* and *xylose*.

The discrepancy in the findings regarding the identity of the sugars is not surprising in view of the fact that we are dealing not with a homogeneous product but with a mixture such as is bound to result from a natural product by simple extraction with water and precipitation with alcohol. The components of such a mixture can be expected to vary according to the conditions of preparation. Our product was obtained by the method as originally described by Ghose and Krishna (1942),[4] namely, extraction of the *ground* seed kernel with water and precipitation by alcohol. Ghose and Krishna have used for analysis a preparation obtained by extraction of pea-size fragments. This slight modification was sufficient, on their own showing, to cause a fall in the protein content of the preparation of about 12 per cent. Corresponding differences in the carbohydrate components are equally to be expected. Obviously there can be no question of studying the chemical constitution of such a heterogeneous mixture until a fraction of constant composition has been isolated from it by preparative methods which would have to be much more specific than mere extraction with water and precipitation with alcohol. Nor was it our object to make such a study in chemical structure. Our data were presented to show that the preparation from tamarind seed, whatever its chemistry may turn out to be, was not a pectin. Pectin as a subgroup of the vegetable mucilages is characterised by being built up mostly or entirely of partially methoxylated galacturonic acid units. The results obtained by us as well as by Ghose and Krishna are in agreement in showing that the substance under consideration does not conform to this composition.

It is necessary not to confuse the issue by emphasising unimportant differences in the analytical results, which, as has been already pointed out were inevitable with the kind of inhomogeneous preparation that was being dealt with, or by references to preparations wrongly called pectin before the chemical nature of pectin was understood. The reference made to Gorter's[5] paper in 1908 in which a substance containing only hexoses and pentoses was called a pectin is as relevant to the present definition of pectin as the original misconception that vitamins are amines is to modern vitamin chemistry. It is true that tamarind seed mucilage has one of the physical characteristics of genuine pectin, that of forming a jelly in the presence of sugar and acid. But on the other hand in another physical property it differs from genuine pectin and resembles starch, *viz.*, in yielding a gummy substance on treatment with borax, a property of starch which is made use of in the manufacture of adhesives. Even in regard to jelly-forming ability the analogy between the product from tamarind seed and pectin is incomplete, as pectin is demethoxylated by treatment with alkali and then loses its jelly-forming ability which is dependent on the presence of methoxyl groups, while the material from tamarind seed appears to be unaffected by such treatment. In any case a chemical classification based upon physical properties would place agar-agar and gelatin in the same chemical group.

Apart from questions of definition and classification, correct characterisation of pectin on chemical grounds is important from the point of view of industrial applications also. The chief commercial uses of pectin are (*i*) for the fortification of jams and preserves from fruits whose natural pectin content is not sufficient to give the desired consistency and (*ii*) for the manufacture of galacturonic acid for vitamin C synthesis. The justification for the use of pectin for the former purpose rests, in the first place, on its being a natural constituent of edible fruits and secondly on what we know of the biochemistry of uronic acids. It is well known that uronic acids are utilised in the human body for detoxication purposes and there is some evidence that the galacturonic acid formed by the hydrolysis of pectin by bacterial enzymes in the large intestines (Kertesz, 1940)[6] may be absorbed and similarly utilised (Manville, Bradway and McMinis, 1936).[7] It is, however, quite a different matter to introduce into food products hexosans or pentosans from non-edible seeds whose behaviour in the alimentary tract is not known—and whose most probable fate would be to undergo fermentation in the colon and produce gas. As to the second application it is obvious that tamarind seed mucilage containing little or no galacturnic acid cannot be used as a source of this substance. The object of our investigation, as has been previously stated,[2] was in fact, to discover suitable sources of pectin for the preparation of galacturonic acid and as our results published elsewhere show (Damodaran and Rangachari, 1945)[8] abundant sources of genuine pectin are readily available.

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POTENCY OF INJECTABLE DIGITALIS PREPARATIONS

DIGITALIS as a useful cardiac tonic has been known in medicine for well over a century. In the form of a fresh infusion of its leaves and an alcoholic tincture which are both official in the British Pharmacopœia, Digitalis has been most frequently used by the oral route. In many cases of cardiac failure, however, absorption from the gastro-intestinal tract is very largely impaired. The need for an injectable Digitalis preparation, therefore, has always been felt.

"Unofficial" preparations available for this purpose are many, the commonest one being called "Digitalin". Nativelle[1] first introduced pure crystalline Digitalin in 1869. This was later proved to be identical with 'Digitoxin' ($C_{41}H_{64}O_{13}$). 'German' Digitalin is, however, not pure Digitoxin but probably a mixture of glycosides obtained from Digitalis seeds consisting largely of Digitonin, Digitoxin and other glycosides. 'French' Digitalin, also known as 'Homolle's Digitalin', is also reported to be a mixture of Digitanin, Digitoxin, and other glycosides. Each of these preparations and lately an American product claimed to be 'German Digitalin', have been used by manufacturers in India for the preparation of injectable products. There is also a feeling in the minds of the physicians that purified glycosides of Digitalis available in this form are less liable to deterioration, which is generally believed to occur with liquid preparation of Digitalis, such as the 'tincture' and the 'infusion'.

As part of our testing service on behalf of the Defence Department and the Director-General, Indian Medical Service, a study of the comparative potency of twelve imported samples of Digitalin was taken up in this Laboratory. The general characters, solubility, potency figures of these samples are given in the accompanying table. The bio-assay method followed was on guinea-pigs as previously recommended from this Laboratory (Bose and Mukerji, 1942).[2] The method briefly consisted of anæsthetizing the animal with intraperitoneal (1·8 gm./kg. weight) urethane, transfus-

Potency of samples in terms of Digitalis pulverta *B.P.**

Sample	Character	Solubility	Strength of solution in alcohol 10%	Mean lethal Dose c.c. kgm.	Potency Unit/ gramme of powder	Potency claimed Unit/ gramme of powder	Percentage of potency in terms of claimed potency
A	Slightly yellowish amorphous powder.	Sparingly soluble in water; soluble in alcohol, solution is clear.	1 in 1,000	23·82	47·39	80	59·2
B	Whitish amorphous powder with small lumps.	Very slightly soluble in water, soluble in alcohol; solution is clear.	1 in 1,000	14·95	75·51	80	94·4
C	Colourless, clear liquid of an agreeable aromatic odour with a bitter taste.	Freely miscible with water and alcohol.	1 in 8	14·25	0·63 (units/c.c.)	1·25 (units/c.c.)	50·4
D	White tablets.	Readily soluble in water and alcohol; solution is clear.	1 in 1,000	13·50	83·62	80 (approx.)	104·5
E	White tablets.	Do.	1 in 1,000	28·00	39·47	80 (approx.)	49·3
F	Greenish hard mass.	Soluble in water and alcohol; solution is almost clear. (Slight haze.)	1 in 1,000	10·89	103·67	80	130·0
G	White tablets.	Readily soluble in water and alcohol; solution is clear.	1 in 1,000	19·00	59·38	80 (approx.)	74·2
H	Do.	Do.	1 in 1,000	12·77	88·40	80	110·5
I	Do.	Do.	1 in 1,000	11·67	96·70	80	120·0
J	Do.	Do.	1 in 1,000	12·07	93·50	80	116·8
K	Do.	Do.	1 in 1,000	17·13	65·89	80 (approx.)	82·4
L	Do	Do.	1 in 1,000	27·40	41·20	80 (approx.)	51·5

* The unitage has been calculated from the average lethal dose, 9.07 c.c. (1·129 units) kg. weight of guineapig, obtained by the authors with the standard digitalis tincture (1 in 80). B. P. C. Standard = 80 I.U. per gramme.

ing Digitalin solution (1 in 1,000) through the jugular vein at the rate of 0·5 c.c./min. till the cardiac pulsations were imperceptible. For each sample, at least six guinea-pigs were tried and the figures in the table represent the mean average m.l.d. figures. The standard deviation of these figures were determined by the usual formula and was found not to exceed 10 per cent. on either side.

It will be seen from the table that commercial preparations of Digitalin, even when stored in powder form in tropical climates, undergoes deterioration. While some figures indicate slightly higher potency than what is demanded by Digitalin, B.P.C. (*i.e.*, 80 units per gramme of powder), there are quite a number which are definitely below this level. This is undoubtedly, at least in part, due to hydrolysis of the glycosides, as it is well established that the aglycons are much less potent than the glycosides from which they are derived. This hydrolysis may be brought about by enzymes, which might remain in the Digitalin samples unless and until they are properly purified, a fact which is seldom achieved in most commercial samples of this category. From the point of view of medical practice, however, it may be a dangerous procedure to use understrength Digitalin, which is used largely as an emergency measure in cardiac failure. It is, therefore, very desirable that all 'Digitalin preparations' must be biologically tested before they are permitted to be employed in the manufacture of injectable 'Digitalins' and similar preparations.

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CHARACTERISTICS OF INDIAN ANIMAL FATS

IVANOW[1] has shown that plants thriving in both hot and cold climates yield, when raised in the tropics, seed-fats that are relatively more saturated, since a certain effective degree of fluidity of the fat must be maintained relative to the environment. Animal fats—milk and depot—from tropical countries also appear to exhibit similar features of saturation. An analysis of 160 cow and buffalo milk fats by Achaya *et al*[2] revealed that the unsaturation varied from iodine value 24 to 40. The comparatively high saturation characterising these fats when compared to those of European origin, which give I.V. exceeding 40, is evident. Also, the I.V. of the cow ghees was about 3 units higher than buffalo ghees of the same R.M. value, there being an inverse relation between the two values in both species.[2]

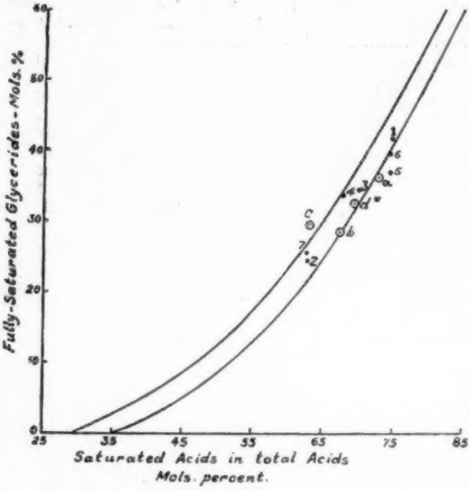
Since the neutral triglyceride component of blood is held to be the precursor of both milk and depot fats, the depot fats may in consequence be expected to reveal analogous differences in saturation. Four samples of Indian cow depot fats examined by Hilditch and Murti[3] showed extremely low I.V. (25·8 to 31·1) compared to Western beef tallows (I.V. about 40); while an analysis of four Indian buffalo depot fats by the authors showed I.V. between 23 and 27 which though too small in number in either case for an unqualified opinion, appear to be of the order of 3 units less as in the milk fats. The extreme saturation of these depot fats has been alrleady noticed by Hilditch and Murti.[3]

In addition to these regional and species characteristics, there are striking peculiarities in the specific glyceride structures of Indian animal fats. Hilditch and co-workers[4] have shown that, if the fully-saturated glyceride percentage of animal fats be plotted against the percentage of total saturated acids of the fats, the points lie on a smooth curve which cuts the saturated acid axis at a point corresponding to about 30 per cent.—which is invariably the proportion of palmitic acid found in these fats, the percentages being about 23 ± 3 in the milk fats and 27 ± 3 in the depot fats. Corresponding points plotted for the fats from Indian animals lie rather on a fairly well-defined line about 4 unit mols. below the former. This new graph cuts the saturated acid axis at a point corresponding to about 35 mols. per cent., in striking agreement with the palmitic acid content of these fats; to make a further particularization, the percentages are about 27 ± 3 for the milk fats and 31 ± 3 for the depot. These relationships are shown below in tabular and graphical form :—

Observer	Total saturated acids (% mol.)	Fully-saturated glycerides (% mol.)	Palmitic acid content (% mol.)
Milk fats			
1. Buffalo Achaya and Banerjee[5]	74·9	41·7	31·9
2. „ Achaya and Banerjee[5]	62·9	24·3	25·1
3. „ Bhattadharya and Hilditch[6]	70·1	34·3	28·7
4. Cow Bhattacharya and Hilditch[6]	67·9	33·7	26·8
5. Sheep Dhingra[7]	74·6	36·8	20·4
6. Goat Dhingra[7]	74·6	39·3	21·5
7. Camel Dhingra[7]	62·6	25·6	28·3
Depot fats			
a. Cow Hilditch and Murti[3]	72·9	35·9	40·8
b. „ Hilditch and Murti[3]	67·5	28·3	33·4
c. Goat Dhingra and Sharma[8]	63·1	29·2	27·0
d. Buffalo Achaya and Banerjee[9]	69·5	32·5	33·4

In addition to the above eleven cases worked out in full, data are available on the palmitic acid contents of three more buffalo milk fats,[5,6,10] and one more cow milk fat[6]; and of two cow depot fats,[3] one buffalo depot fat[9] and seven wild animal depot fats of Eastern animals.[11] These figures indeed strikingly confirm the new glyceride relationship postulated above which certainly appears more than coincidental.

Of the five apparent exceptions, the goat and sheep milk fats of Dhingra[7] were from animals on a winter diet in the Punjab and may indeed be said to support the contention that it is in a tropical climate that the above relationship



Comparative Glyceride Structures of Indian and Western Animal Fats

would hold; the low palmitic content of the buffalo milk fat (19·0) of Bhattacharya and Hilditch[6] and of the sacred baboon fat of Hilditch, Sime and Maddison[11] is no doubt due in the former case to unknown dietary factors, possibly cottonseed meal (*cf.* Achaya and Banerjee[5]), and in the latter to the high unsaturation of the fat and low content of total saturated acids. The reverse reason might also explain the high figure of 45·6 obtained by Achaya and Banerjee[9] in a buffalo depot fat of I.V. 23·8.

We wish to thank Prof. V. Subrahmanyan for his encouragement in the course of these investigations, which will be published elsewhere in full.

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ON THE PREPARATION AND COMPOSITION OF NEGATIVELY CHARGED FERRIC PHOSPHATE SOL AND GEL

THE sols and gels of various ferric salts have been described in previous communications to this *Journal*.[1] This paper records my results on the composition of negatively charged ferric phosphate sol and the preparation of the hydro-gel.

When potassium di-hydrogen phosphate is added to ferric chloride solution a yellowish white precipitate is obtained. It is observed that this precipitate of ferric phosphate can be dispersed by caustic soda or ammonia to give a bright red sol of ferric phosphate which bears a negative charge. The peptisation is greatly facilitated by the addition of glucose and glycerine. In a paper Mushran and Prakash[2] have studied the detailed conditions of the preparation of this sol.

The sol under investigation was prepared by mixing 40 c.c. of ferric chloride (corresponding to 30·36 gms. of Fe_2O_3 per litre), 40 c.c. of 10 per cent. potassium dihidrogen phosphate solution, 20 c.c. of glycerine and 80 c.c. N-NaOH solution. The total volume was raised to 200 c.c. The sol was dialysed for fifteen days.

The analysis of the coagulum of the sol obtained by the cataphoretic method indicated that the empirical formula of the suspension was $5\,Fe_2O_3 .\ 2\,FePO_4 .\ 11\,H_2O$.

The coagulum obtained from this sol by the use of electrolytes is gelatinous, but it could not set to a gel. I have obtained the gel, however, by the desiccation method. About 20 c.c. of the sol was allowed to evaporate slowly over concentrated sulphuric acid in a desiccator. After a week the sol was found to set to a transparent stiff jelly.

Further work on this sol and gel is in progress.

My thanks are due to Dr. Satya Prakash for his kind interest in this work.

Chemical Laboratory, S. P. MUSHRAN.
The University of Allahabad,
October 12, 1945.

1. Mushran., *Curr. Sci.*, 1945, **14**, 123, 200, 233. 2. Mushran and Prakash., *Allahabad, Univ. Studies.*, 1943, **19**, 1.

STUDY OF THE COMPOSITION OF CHLOROMERCURIC ACIDS BY THE ELECTRICAL CONDUCTIVITY METHOD

THE electrical conductivity method of Dey and Bhattacharya[1] has been applied to the study of the chloromercuric acids and their potassium salts and the results are recorded in this note. The method consists in the measurement of the electrical conductivity of the individual solutions of chlorides and also of the mixtures of the mercuric chloride solution with varying concentrations of the hydrogen or potassium chloride solution. It was found that the mixture was more conducting than either constituent and the conductivity values were even greater than the sum of the conductivities of the constituents. In a graph the percentage

difference between the sum of the conductivities of the constituents and the observed conductivity of the mixture, is plotted against the concentration of the chloride solution. The graph gives a periodic curve with breaks corresponding to 1, 2 and 4 molecules of HCl for one molecule of $HgCl_2$. Thus the results afford the evidence for the presence of the following complex chloromercuric acids in a mixture of solutions of mercuric chloride and hydrochloric acid: $HHgCl_3$, H_2HgCl_4 and H_4HgCl_6. The corresponding potassium salts are also found to be present in a mixture of solutions of mercuric chloride and potassium chloride.

Detailed procedure with curves and the results will be published elsewhere.

I thank Dr. A. K. Bhattacharya for his helpful criticism and advice.

Department of Chemistry,
University of Allahabad, ARUN K. DEY.
October 12, 1945.

1. Dey and Bhattacharya *Curr. Sci.*, 1945, **14**, 69.

THE CYTOLOGY OF THE YEAST

THE striking advances in the realm of Cytology in recent years have unfortunately not embraced the industrially important micro-organisms, like yeast. The exact nature and behaviour of the nucleus in this important organism have remained more or less in the region of doubt.

A preliminary examination of smears of *Saccharomyces cerevisiæ* (?), fixed and stained accordance with well-known methods, has revealed the following features. Wort cultures of a certain strain of *Saccharomyces cervisiæ* were left for 24 hours after which the wort was renewed as it is well known that the organism goes into vigorous activity for a short period in the fresh wort. Smears were made during this short active span and fixed in Karpechenko's modified formula for Nawaschin, and in Levitski's mixture. The smears were then tested for the Feulgen's reaction after a mild acid hydrolysis. Individual cells show a clear cytoplasm enclosing a vacuole wherein are found one to about five Feulgen positive bodies (Figs. 1 to 5). These bodies are of

Figs. 1 to 4 × 3600

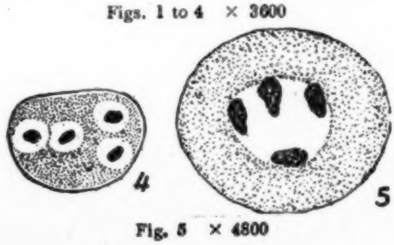

Fig. 5 × 4800

varying sizes and shapes in adjacent cells and appear in different sites of the intra-nuclear vacuole. They represent portions of the nuclear material. Apparently these are regions with an excessive charge of nucleic acid and remind us of the heteropycnotic areas so well known in nuclei. The varying sizes and shapes which these bodies present under the influence of the same fixative should be sufficient caution against succumbing to the easy temptation of mistaking these for actual chromosomes.[1,2] This must be especially so in view of the fact that the dimensions of the chromosomes of an individual are genetically controlled.

The fact that the nuclear material of the yeast gives a positive Feulgen reaction imports into the picture the validity of the time honoured concept regarding the type of nucleic acid here. The yeast nucleic acid is believed to be a pentose nucleotide not incorporating a desoxy sugar. Since the Feulgen test is specific for desoxy-pentose nucleic acid, it raises the important question whether all the *Zygosaccharomyces* contain the pentose nucleic acid which is Feulgen negative and stable to the action of the acids.

Further work is in progress.

Department of Botany,
Central College,
Bangalore, K. V. SRINATH.
January 7, 1946.

1. Badian, M., *Bull. Int. Akad. pol.* 1937, **B**, 1. 1–5.
2. Subramaniam, M. K., and Ranganathan, B., *Curr. Sci.*, 1945, **14**, 78.

ASPARAGINE FROM INDIAN PULSES

l-ASPARGINE is a fine chemical in bacteriological and immunological routine; it provides an ideal source of organic nitrogen, readily assimilable by micro-organisms including yeasts. Considerable quantities of asparagine are employed in the production of tuberculin, diphtheria antitoxin, etc. Shortage of this fine chemical during war led us to investigate the possibility of preparing this chemical from indigenous sources. The four abundantly available pulses, green gram (*Phaseolus mungo*), black gram (*Phaseolus radiatus*), Bengal gram (*Cicer aritinum*), and horse-gram (*Dolichos biflorus*), have been studied for their capacity to yield asparagine on germination and growth. The method described by Vickery, Pucher and Deuber[1] has been closely followed in the preparation of etiolated seedlings.

EXPERIMENTAL

The seeds were steeped in running tap-water for 48 hours; after draining, the sprouting seeds were uniformly spread in trays furnished with fine wire-mesh and transferred to a cabinet provided with air-holes at the bottom and a flue at the top; this arrangement facilitated aeration of the growing seedlings. The seedlings grew in darkness, and were periodically sprayed with water. With a view to determine the day on which the maximum amount of asparagine was formed, the seed-

TABLE I

Analysis of Water-Soluble Nitrogen of the Extracts

Days	Green Gram Per 100 g of pulse				Black Gram Per 100 g pulse				Bengal Gram Per 100 g. pulse				Horse Gram Per 100 g of Pulse			
	Total Solids (g.n.)	Total N (g.)	Amide N (g.)	Amide N as % of Total N	Total Solids (g.)	Total N (g.)	Amide N (g.)	Amide N as % Total N	Total solids (g.)	Total N (g.)	Amide N (g.)	Amide N as % of Total N	Total Solids (g.)	Total N (g.)	Amide N (g.)	Amide N as % of Total N
1	—	—	—	—	11·8	0·34	0·05	13·23	10·0	0·42	0·037	9·00	16·1	0·37	0·034	9·154
2	—	—	—	—	13·8	0·34	0·06	16·93	10·7	0·40	0·037	9·41	14·	0·63	0·102	16·01
3	19·3	1·48	0·03	3·89	12·9	0·51	0·07	13·80	10·3	0·41	0·041	10·03	15·1	0·82	0·162	19·55
4	25·0	1·67	0·15	9·27	24·7	1·04	0·14	13·11	9·0	0·41	0·052	12·53	21·0	1·23	0·240	19·63
5	19·9	1·80	0·33	18·18	25·6	1·31	0·17	13·27	10·1	0·54	0·098	18·20	22·3	1·58	0·333	21·09
6	16·9	1·67	0·61	36·08	27·4	1·74	0·23	13·30	12·5	0·59	0·131	[illegible]	20·80	1·58	0·379	23·36
7	15·9	2·13	0·68	31·92	22·5	1·89	0·40	21·21	12·6	0·73	0·155	21·32	20·0	1·54	0·425	27·48
8	14·3	2·13	0·75	35·24	21·8	1·96	0·42	21·77	13·7	0·70	0·132	22·02	19·30	1·71	0·487	30·31
9	14·2	2·12	0·79	37·27	20·9	2·02	0·50	25·12	13·2	0·75	0·150	23·52	21·4	1·98	0·501	25·34

lings (200 in number) have sampled out at every 24 hours and immediately blanched in water kept vigorously boiling for this purpose; the treatment served to arrest the enzymatic activity of the tissues. The material was then ground up with water and extracted twice with water (by keeping on a boiling water-bath for 15 minutes). The combined extracts were acidified to pH 5·6, kept overnight, filtered and the filtrate made up to 500 c.c. Samples were treated in this manner for nine days and all the pulses were taken up for investigation. The resulting filtrates are analysed for (1) total solids by evaporation, (2) total nitrogen (by Kjeldahl) and (3) amide N as suggested by Jodidi and Kellogg.[2] The results of the analyses are embodied in the above table.

DISCUSSION

The results have been calculated as percentages on the weight of the seeds and are given in Table 1. It will be observed that (1) the percentage of water-extractable total solids rises in the earlier stages of growth and later tends to diminish, (2) a steady increase in the percentage of total and amide N in the extracts. Assuming that the amide N represents the asparagine content of the seedlings, it can be seen that of the pulses examined green gram (*Phaseolus mungo*) constitutes the richest source of asparagine. It should, however, be pointed out that the results indicate that by allowing the seedlings for longer periods, a further enrichment of the extract with respect to asparagine may be obtained.

M. R. RAGHAVENDRA RAO.
M. SREENIVASAYA.

Section of Fermentation Technology,
Indian Institute of Science,
Bangalore,
December 25, 1945.

1. Vickery, H. B., Pucher, G. W., and Deuber, C. G., *J. Biol. Chem.*, **1942**, **145**, 45. 2. Jodidi, S. L., and Kellogg, E. H., *J. Agr. Reserch.*, **1918**, **15**, 385.

WANTED A MUSEUM OF EVOLUTION

I HAVE read Mr. Randhawa's note entitled "Wanted a Museum of Evolution" in the November issue of *Current Science* with interest. This is a suggestion of far-reaching possibilities. Unless a deliberate attempt is made now by the leaders of public movement to wean the Indian mind from the futile ideological pursuits which pass under the name of religion, the state of "virtual civil war" between rival religious idealogies in this country will remain and perhaps increase in volume.

The best substitute for this so-called "religion" would be the right type of knowledge of fundamental facts of science, which, if imparted and diffused in the manner suggested by Mr. Randhawa, is sure to fertilise the mind of the average man, woman and child and lead it to constructive healthful pursuits. At present negative action and attitude of mind are rampant in many phases of our national life.

Of the branches of science none is likely to appeal more to our people than the science of Life-Biology, which comes nearest to their innate philosophical susceptibilities. Such "museums", after the first inevitable doubts and criticisms will soon become popular and unconsciously, in course of time, make people science-minded. A science-minded India will take its rightful place in the world more easily than the present ultra-religious minded population, seething with fissiparous tendencies and scenting danger to their faiths in all moves for common action or unity.

Ten lacs of rupees will give a fair number of such "museums" to our principal cities. The donor of this gift will give to India monuments more lasting and beneficial than any number of temples, mosques or churches.

New Delhi, D. N. WADIA.
December 19, 1945.

REVIEWS

Frontiers in Cytochemistry. *Biological Symposia*, Vol. X. Edited by Normand L. Hoerr. (The Jacques Cattell Press, Lancaster, P.A.), 1943. Pp. viii + 334. Price $3.50.

Pupils of Professor Bensley, who had been inspired by his teachings and influenced by his pioneering work in the domain of cytochemistry, organised a symposium to celebrate his seventieth birthday; the theme of the symposium was to include his monumental researches which constituted his principal preoccupation during the preceding ten years—the physical and chemical organisation of the cytoplasm. The symposium was in all appropriateness, held at the University of Chicago—the scene of Prof. Bensley's activities. The proceedings of this symposium constitute the contents of the volume under review.

Discussions of thirteen different topics ably presented by his foremost associates covering most of the physical and chemical aspects of cytochemistry, are included in this volume. These are prefaced by a foreword by Normand L. Hoerr which gives a picturesque review of the highlights of Prof. Bensley's discoveries and experimental techniques; at the end of the volume, there is a reproduction of Professor Bensley's article on "The Chemistry of Cytoplasm" originally published in *Science*.

The conception of "Separating separable components of the cell first" before subjecting them to analysis, was first introduced by Prof. Bensley and methods of accomplishing this task through differential centrifugation Altman freeze-dehydration, and microincineration, were developed by his pupils.

Arnold Lazarow reviewing the chemical structure of cytoplasm as revealed by the work of the Bensley school, puts forward the concept that the cell is endowed with a structural organisation "which is due, in spite of a continuous aqueous phase, to an orientation of asymmetric micelles". The subject of cellular respiration which is a fundamental property of the living cell is presented by Guzman Barron from the view-point of the oxidation-reduction systems which participate in the reaction. Ultra-centrifugal studies on cytoplasmic components and inclusions are described by H. W. Beams, whose work in the field of the inexpensive and elegant air-driven ultracentrifuge, is well known. This article is well illustrated with revealing microphotographs lucidly reproduced. Albert Claude has contributed on the distribution of nucleic acids in the cell and the morphological constitution of cytoplasm. A further discussion on the application of the centrifuge in cell studies is given in this article. Experimental carcinogenesis in mice is the caption of an interesting contribution by E. V. Cowdry, in which the cell and nuclear volumes, mitotic frequency, nucleocytoplasmic ratios, response to colchicine, have all been described. The article by Isidore Gersh on histochemical analysis of changes in *Rhesus motoneurons* will be found interesting to those interested in the application of ultraviolet absorption microscopy to cytochemical problems. Of special interest to biochemists in general, are the articles on (1) macromolecular particles endowed with specific biological activity, and (2) fibrous nucleoproteins of chromatin which should prove particularly valuable to workers in the field of cytogenetics. Only a few of the points from a few of the articles contained in this exceedingly interesting and valuable collection, have been presented. The volume, which every cytochemist should own, is one which will inspire further lines of work and open out new vistas of thought and thus extend the frontiers of chemistry.

Advances in Protein Chemistry, Vol. I. Edited by M. L. Anson and John T. Edsall. (Academic Press Inc., New York), 1944. Pages xi + 341. Price $6.00.

Proteins constitute a naturally occurring and widely distributed group of fundamentally important compounds intimately associated with life and its processes; they play the vital role in the sustenance of life, in its propagation and in promoting the performance of all the functions characteristic of life. They have attracted the attention of several generations of investigators and there is scarcely any branch of science and hardly any experimental technique which has not been utilised to investigate the many-sided aspects of this fascinatingly complex and intriguingly elusive group of compounds. "The technique now used for the study of proteins range from the most elaborate form of X-ray analysis to quantitative measurements of antibodies. Workers in the most diverse fields of science have not only contributed to the development of techniques, but have become interested themselves in applying the techniques they helped to develop in the study of the problems of Protein Chemistry."

Proteins embrace the entire group of enzymes, some of the harmones, which regulate the processes of life, the viruses which afflict man, beast and plant and the chromosomes and the genes—the self-duplicating units of life and the carriers of heredity. In association with certain prosthetic groups, certain specific proteins acquire the power of a catalytic enzyme, an infective virus or a self-propogating gene.

In practical nutrition, curative immunology and preventive medicine proteins are indispensable and more recently they have invaded the field of technology. In view of the wide and varied interest bestowed upon the subject, the literature pertaining to it lie scattered over an ever-expanding field of literature. The need for periodical reviews on the various aspects of this subject has long been keenly felt and the series of publications heralded by the volume under review, is expected to fulfil an urgnt requirement in scienitfic literature.

It is a happy coincidence the year of publication of these *Advances* should have synchronised with the centenary of the discovery of nucleoproteins whose vital significance has subsequently been revealed. Eight reviews, covering mostly the fundamental aspects of protein chemistry, are included in the volume; Lipoproteins which are intimately associated with the structure and functions of the living cell, form the topic of a discussion by Erwin Chargaff. The isolation of these bodies, their physical, structural and antigenic properties are described. The second chapter is devoted to a discussion of the structural proteins of cells and tissues; the ultra-structure of the intracellular proteins as also that of the specific tissues, nerve, collagen, myosin and fibrin, as revealed by X-ray diffraction, electron microscope and polarised light, are given. The review on some contributions of immunology to the study of proteins will prove one of special interest to immunochemists.

The chapter on the purification and properties of protein represents an exceedingly well presented review which will repay a close study not only by investigators interested in a study of the hormonal proteins, their isolation, their purity and identity with the protein molecule or otherwise, also by enzyme chemists who are confronted with equally intriguing questions of purity, homogeneity and activity.

The masterly and critical presentation of our present knowledge relating to nucleoproteins by Jesse P. Greestein will be eagerly read by a large circle of investigators including those interested in cytogenetics. The article represents one of the most comprehensive reviews on the subject which have appeared in recent years. Keneth Bailey's review on the skeletal muscle gives a clear exposition of the subject which should prove equally valuable to biochemists and physiologists. The chapter pertaining to soyabean, we are afraid, presents a one-sided view of the problem; the facts and findings in this question have not been critically appraised; this is the impression which is created by a perusal of this review.

According to the enterprising editors, the second volume in the series will include a bunch of contributions which will "reflect the increased interest in protein nutrition stimulated by the war. These will include discussions of the estimation of amino-acids by chemical and bacterial growth methods, of the amino-acid content of protein foods, of protein nutrition in man and of the relation of protein nutrition to antibody formation". *Advances in Protein Chemistry* promise to constitute a valuable and stimulating series which would be eagerly welcomed by all interested in the fundamental and applied aspects of protein chemistry.

Dictionary of Metallography. By R. T. Rolfe. (Chapman & Hall, Ltd.), 1945. Pp. viii + 242. Price 15/-.

A treatise dealing with some particular branch of a technical subject is usually reviewed by someone expert in the appropriate field of knowledge. On the other hand any form of technical dictionary (and Mr. Rolfe's *A Dictionary of Metallography* is no exception) covers such a wide field of information that a comprehensive review is hardly possible by a single person and I must ask the reader to bear this limitation in mind.

It is my pleasant duty to record that a cursory reading of the book failed to reveal any of the gross errors which so often characterise works of this type.

Judging from items which deal with subjects with which I am conversant, Mr. Rolfe is up to date and accurate in his information. For example, it is refreshing to observe that the melting point of chromium is given at 1830° C. and not some value near 1500° C.—a figure quoted too often at the present day. Further, it is explained that the pure metal is reasonably soft and ductile and that the intense hardness usually encountered is due to the presence of carbide. The limits given for the phase fields in the high temperature region of the iron-carbon diagram are also in accordance with recent work carried out on high purity materials.

Reviewers sometimes draw attention to small discrepancies, if only to make it clear that they have read the book but Mr. Rolfe's dictionary does not give much scope for this form of activity.

Under the heading of "Electric Furnaces" and on page 71, reference is made to a spiral inductor coil which fits over a crucible. Strictly speaking, the coil is generally in the form of helix—although even here the author has some justification for whoever speaks of a helical staircase.

On page 60 the lower limit of the "delta" form of iron is stated as 1390° C., while on page 94 the older figure of 1404° C. is given for the gamma-delta transformation.

The author has accomplished the difficult task of condensing all the entries into the smallest compass compatible with clarity—with marked success.

In a dictionary the sins of omission can sometimes be greater than those of commission but *A Dictionary of Metallography* must be exempted from any criticism on this account. Altogether the little volume justifies both the established reputations of the author and publishers and my copy has at least one useful attribute—it stays open at any page.

FRANK ADCOCK.

Radio Receiver Design—*Part II. Audio Frequency Amplifiers, Television and Frequency Modulated Receiver Design.* By K. R. Sturley. (Chapman & Hall, Ltd., London, W.C. 2), 1945. Pp. 480. Price 28*sh.* net.

This book is in continuation of the author's *Radio Receiver Design*, Pt. I, and deals with the remaining stages of the radio receiver for amplitude-modulated signals as well as all stages of frequency-modulated and television receivers. This work, together with the previous one by an experienced radio engineer and writer like Dr. K. R. Sturley, is a true indication of the present position of radio receiver design.

The book is divided into eight chapters (numbered nine to sixteen chapters), the first

six of which relate to audio frequency amplifiers, power output stage, power supplies, automatic gain control, tuning controls and measurement of overall performance of radio receivers. The frequency-modulated and television receiver design is given in the last two chapters.

While no pain has been spared by the author in dealing with the topic under each of the first five chapters as thoroughly as possible and bringing it up to date, special mention may be made of the power supplies, automatic gain control and tuning controls which have been treated so well here but have not received adequate attention in other works on the same subject. The amplitude and phase discriminators have been dealt with exhaustively. It is, however, felt that the chapter on the "measurement of overall performance of the radio receivers" should have been more exhaustive. Topics like "random noise" and its measurement should have received more space.

The usefulness of the book has been considerably increased by the inclusion of the last two chapters on the design of frequency-modulated and television receivers which are at the present time, no less important than the amplitude-modulated receivers.

The book is packed with useful formulæ, graphs and figures which will prove extremely handy to the designer of radio receiver. The bibliography given at the end of each chapter includes the well-known papers on the subject which are quite useful to the reader. The printing and get-up of the book are excellent.

The reviewer warmly recommends this excellent work together with the previous one by the same author to radio receiver designers and engineers as well as to post-graduate and research students on the subject.

S. P. Chakravarti.

Selected Topics from Organic Chemistry. By D. D. Karve and G. D. Advani. (Dastane Brothers' Home Service, 456, Raviwar Peth, Poona 2.) Pages 284. Price Rs. 8.

Written on the lines of *Model Essays in Organic Chemistry* by the same authors,, the book under review contains thirty short chapters on the following topics in organic chemistry, *viz.*, Carbohydrates, Alcoholic Fermentation, Tannins and Related Products, Proteins and Polypeptides, Polymethylenes, Terpenes and Camphors, Natural and Artificial Rubber, Vegetable Alkaloids, Uric acid and other Purine Derivatives, Carotene and Flavones, Constitution of Chlorophyll, Anthocyanins, Synthetic Dyes and Drugs, Vitamins and Hormones, Structural Formula of Benzene, Substitution in the Benzene Ring, Electronic Formulæ of Organic Compounds, Relation between Colour and Chemical Constitution, Relation between Physical Properties and Chemical Constitution, Unsaturation, Organic Compounds containing Elements with Abnormal Valency, Catalysis, Oxidation, Reduction, Some Important Condensation Reactions, Stereochemistry, Tautomerism, Detection and Estimation of Groups, and Structure and Orientation of Organic Compounds. A set of questions and a bibliography are also included. Each chapter is a brief summary of the pertinent literature available in text-books and treatises presented in a form easily assimilable by and very helpful to students appearing for the first Degree Examination in chemistry. The material incorporated in the book covers much of the important section of the syllabus in organic chemistry for B.Sc. and B.Sc. (Hons.) courses. While the candidates must make use of standard works on higher Organic Chemistry as prime source of knowledge, the present volume should prove very useful to them as a handbook for "revision study" and as an "examination aid".

Although an 'Errata' slip has been included, there are still a few more printing errors. To cite a few: On page 59, line 1, "ββ-diethylglutarate" should be "diethyl ββ-dimethylglutarate"; on page 185,

$$\begin{array}{c} H \\ | \\ H\text{—}N\text{—} \\ | \\ N \end{array} \text{ should be } \begin{array}{c} H \\ | \\ H\text{—}N\text{—}; \\ | \\ NH \end{array}$$

on page 238, in the formulaæ for ββ-dimethylglutaric ester and diketo-cyclopentane-dicarboxylic ester, the central "$-CH_2-$" should be "$-CMe_2-$"; on page 239, line 11, "from" should be "form".

B. H. Iyer.

The Indian Central Cotton Committee—Twenty-third Annual Report, 1944. Rs. 2.

The Report under review gives a summary of the research and other activities of the Committee for the year ending 31st August 1944. As such it does not take upon itself the onus of forecasting the future of the cotton crop in this country, especially now, when the second World War has come to a close. Serious attempts will have to be made to assure our farmers that the sweat and toil so intimately associated with men of their lot will not be in vain. As it stands, the layman feels that in the competition that is to inevitably arise between the artificial rayon and cotton, the former may emerge out as a victor though not a convincing victor, over the product of the earth. Still, two of the resolutions unanimously passed in the meetings held in 1944 clarify the position as regards an oncoming cotton crisis in the near future. The first resolution that "in the opinion of the Committee, resolute and determined steps should be taken at once effectively to stop the malpractice of mixing of cottons. The Committee accordingly authorises the local sub-committee to go into the matter, take such action as it can and put up its final proposals for confirmation at the next monsoon meeting of the full Committee". The second important resolution on the question of the paramount urgency of growing more food is, "the Committee is convinced that the object in view can be achieved by improved methods of farming, suitable rotation of crops, and, above all, where conditions are favourable, by the introduction of mechanical devices for culture and harvesting operations. It accordingly requests the Government of India to give immediate facilities for manufacture in the country and import from abroad (to meet immediate requirements) of improved implements and machinery and fertilizers".

The first of the above resolutions demands very serious consideration. The question is whether the enforcement of law by legislation would be feasible in a matter of the gravest importance as that of mixing of short and long staple cotton in factories. The answer is that one has to be sceptic about this approach with existing conditions. It might be more readily practicable if this malpractice and its ultimate repercussions be given the widest publicity throughout the cotton-growing tracts which might in turn ultimately educate the masses. The second resolution mentioned above is again only a recommendation. It is intimately linked up with policies of a far-reaching nature, namely, the industrial development of this country. There is hardly any need for the reviewer to point out that it needs a very bold agricultural policy on a national scale to make this resolution a success, as for instance, we are told, has been the good fortune of the Russian peasant.

In addition to the above points, the reviewer was attracted by the reference made by the Cotton Committee on the severe hardship to the cotton cultivators by the lowering of the floor and ceiling prices. This resolution, although giving a true picture of the heavy suffering the farmer toils under, may not straightaway relax his difficulties. Nevertheless one must appreciate the standpoint taken by the Committee and wish that their efforts are crowned with success.

The rest of the Report deals with the progress of various researches underway in the country. The Cotton Committee certainly demands our praise at the very varied services it is rendering to the cause of cotton in India but apart from its excellent seed distribution and other schemes it may be worthwhile extending its finances to Universities for fundamental researches on the nutritional physiology of the cotton. For work of this type, quite a large number of University Departments are ideally equipped. A central scheme for co-ordination on these fundamental problems can be chalked out and immense quantity of valuable data collected if problems are distributed to various Universities and run on proper lines. It would be difficult to deal with the various aspects of the subject-matter presented in the Report under review and the reviewer wishes to point out that for any one interested in the latest position as regards cotton-growing in India, this Report would be indispensable.

T. S. SADASIVAN.

SCIENCE NOTES AND NEWS

Lady Tata Memorial Trust: Scientific Research Scholarships, 1946-47.—The Trustees of the Lady Tata Memorial Trust are offering ten Scientific Research Scholarships of Rs. 150 each per month for the year 1946-47 commencing from 1-7-1946. *Applicants must be of Indian Nationality and Graduates in Medicine or Science of a recognised University. The Scholarships are tenable in India only and the holders must undertake to work whole-time under the direction of the head of a recognised research institute or laboratory.* The subject of scientific investigation must have a bearing either directly or indirectly on the alleviation of human suffering from disease. Applicants are required to furnish the following information in their applications along with certificates of physical fitness and character:—

(*a*) Full name, (*b*) Age, (*c*) Sex, (*d*) Permanent address, (*e*) Details of academic career (*f*) Particulars of previous research work, (*g*) Particulars of the proposed research, and (*h*) *Particulars of other emoluments, scholarships and pay or any other financial support from friends or relations they are or will be in receipt of during the period they are Scholars.*

In stating the particulars of the proposed research under (*g*) applicants must give (*a*) a short resume on the subject of research indicating the present state of knowledge and (*b*) details of the proposed research indicating (*i*) the methods intended to be employed, (*ii*) previous experience in the use of these methods and (*iii*) the experiments to be carried out.

Applications must be forwarded through the Director of a recognised Research Institute or Laboratory where the applicant proposes to work and must be accompanied by a letter from the Director or Head of the Department concerned stating that he has critically examined the details of the proposed research, that he approves of the general plan and that he is willing, as far as possible, to guide and direct the investigation and give laboratory facilities.

Applications, which must be typed, must give full particulars in the order indicated above and must be addressed to the Secretary, The Lady Tata Memorial Trust, Bombay House, Bruce Street, Fort, Bombay, so as to reach him not later than 15th March 1946.

Journal of Colloid Science.—The Academic Press, Inc., New York 10, N.Y., have announced that the first issue of this new bi-monthly is scheduled to be published in January 1946. The *Journal* is priced at 10 dollars a year. We have no doubt that the publication, which is the first of its kind in the English language, will receive world-wide welcome, both from scientists and technologists.

Dr. U. N. Chatterji, M.Sc., D.Phil., officiating Editor of Journals, Imperial Council of Agricultural Research, New Delhi, has received the D.Sc. degree of the University of Allahabad for his thesis on "Physiological studies on some intermediate steps in plant respiration".

Mr. Sukhsampttirai Bhandari, M.R.A.S., Author and Publisher, Dictionary Publishing House, Brahmpuri, Ajmer, has announced the publication of three volumes of *20th Century English-Hindi Dictionary of Scientific and Technical Terms.* This appears to be the first work of its kind in Hindi.

8-46 Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent and Published by Dr. M. A. Govinda Rau, M.A., Ph.D., for The Current Science Association, Bangalore

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